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Degradation in Manual Dexterity Tasks Attributable to the Mark 6 Prototype New Concept NBC Protective Glove *Final Report*

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EXECUTIVE SUMMARY

The Defence Research Establishment in Ottawa (DREO) is currently developing a new concept nuclear biological chemical (NBC) protective glove design. The latest prototype, the Mark 6, has been produced using two types of material: natural latex and bromobutyl rubber. The purpose of this investigation was to evaluate the influence of four hand wear conditions on performance in four tests of manual dexterity. The four hand wear conditions included Bare Hands, Latex, Molded (bromobutyl rubber), and Molded+Liner. All tests were performed with bare hands to determine baseline values for calculation of degradation in manual dexterity test performance attributable to gloves. Previous glove prototypes were all made of a natural latex; therefore, it was necessary to test a natural latex version of the Mark 6 design to compare performance degradation. The Mark 6 compression molded design was made of bromobutyl rubber which is more representative of an actual NBC protective material. The protective glove may eventually be used with a fabric liner in the field; therefore, the fourth hand wear condition consisted of the molded glove worn with a seamless string knit liner.

A test protocol was developed which incorporated four dexterity tests: the Minnesota Rate of Manipulation Test, the O'Connor Fine Finger Dexterity Test, the Cord Manipulation and Cylinder Stringing Test, and the Magazine Loading Test. Anthropometric measurement of the hand and subjective fit evaluations of the prototype gloves were also components of the test protocol. Fifteen male volunteer subjects from an Ottawa militia regiment who had been screened for hand size participated in the study.

The experimental results revealed significant and dramatic performance differences between the different hand wear conditions. The Bare Hand condition was consistently faster than all others in each test. The next fastest test completion times were performed with the Latex glove. The Molded (unlined) glove produced faster times than the Molded+Liner condition only in two tests: the O'Connor Test, and the Cord and Cylinder Test.

Subjective ratings of perceived performance effects were fairly consistent with the test findings. On average, subjects perceived significantly less performance degradation for the Latex condition (2.8, closest to the "degraded my performance a little" qualifier) than the Molded glove conditions. The Molded and the Molded+Liner conditions (2.2 and 2.3, respectively) were not significantly different and were closest to the "degraded my performance a lot" qualifier.

Performance degradation values for the Mark 6 Latex prototype did not differ significantly from previous prototypes for any of the tests. The Molded and Molded+Liner versions of the Mark 6 did show dramatic increases in manual dexterity test performance degradation as compared to all other prototypes. For instance, prototypes made from natural latex, including the Mark 6 glove, produced performance degradation values ranging from 29% to 40% for the Cord and Cylinder test. Degradation values for Cord and Cylinder test performance were a high as 73% and 86% for the Molded and the Molded+Liner glove conditions, respectively.

Discussion and recommendations for design changes and further research were put forth. It was obvious from the results that the bromobutyl rubber gloves dramatically affect manual dexterity, especially for fine motor tasks such as the cord and cylinder stringing. Several factors could contribute to this performance degradation including material thickness (approximately twice that of the natural latex glove), material stiffness, and possibly reduced coefficient of friction of the bromobutyl rubber. New functional, yet protective materials should be examined. As well, further human factors investigation was recommended. Among the recommendations for further study, it was suggested that hand anthropometrics be applied to glove size and shape design. Field testing of the resulting design should be then conducted.

ABSTRACT

A new concept nuclear biological chemical (NBC) protective glove design is currently being developed at the Defence Research Establishment in Ottawa (DREO). A natural latex dipped and a compression molded bromobutyl rubber version of the latest, Mark 6 design were recently developed and produced (in small quantities) at the DREO. The purpose of this investigation was to evaluate the influence of four hand wear conditions on performance in the manual dexterity tasks and on subjective measures of fit, function and comfort. The hand wear conditions were Bare Hands, Latex glove, Molded glove, and a Molded glove plus a string knit Liner. Four manual dexterity tests were conducted for each glove condition : the Minnesota Rate of Manipulation Test, the O'Connor Fine Finger Dexterity Test, the Cord Manipulation and Cylinder Stringing Test, and the Magazine Loading Test. This report summarizes the development of the manual dexterity test protocol as outlined in detail in an earlier report (Weihrer and Rhodes, 1991). This report presents the results of the dexterity testing, and recommendations for further modification of the new concept glove design.

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LIST OF ABBREVIATIONS

NBC	-	Nuclear Biological and Chemical
CW	-	Chemical Warfare
DREO	-	Defense Research Establishment Ottawa
ANOVA	-	Analysis of Variance
n	-	Statistical notation representing the number of subjects
s	-	Seconds
mm	-	millimetres
cm	-	centimetres
kg	-	kilograms
mil	-	1 mm = 40 mil = .04 inch
α	-	statistical symbol representing the probability of a Type I error
Bare Hand	-	This refers to the experimental condition in which the tasks are performed with **Bare Hands**
Latex	-	This refers to the experimental condition in which the tasks are performed wearing a natural **Latex** dipped glove
Molded	-	This refers to the experimental condition in which the tasks are performed wearing a bromobutyl rubber compression **Molded** glove
Molded+Liner	-	This refers to the experimental condition in which the tasks are performed wearing the same bromobutyl rubber compression **Molded** glove with a knit **Liner** under the glove

1.0 INTRODUCTION

1.1 Background

A new concept nuclear biological chemical (NBC) protective glove is being developed at the Defence Research Establishment in Ottawa (DREO). The new concept glove is one that is symmetrical; that is, there is no designated left-hand or right-hand glove.

In 1987, a preliminary version of the new concept glove was designed, and a small quantity of prototype gloves were produced. An evaluation of these prototypes was conducted by Johnson, Forsyth, and Rhodes (1987). This initial prototype design for the new concept glove was labelled as the first generation new concept glove. The purpose of the evaluation was to assess the impact of the new design concept on manual dexterity. These researchers found that, in terms of performance in tests of manual dexterity, there was generally no significant difference between the prototype glove, worn without a glove liner, and the Canadian in-service lightweight chemical warfare (CW) glove. This result demonstrated that the new concept was a functionally feasible one. Based on the experimental observations and results, Johnson et al. (1987) made a number of recommendations for modification of the first generation new concept glove design.

1.1.1 Glove Prototypes

Since the initial feasibility testing of the first generation new concept glove, five different prototypes, each with specific design modifications, have been developed. These prototypes have been labelled: Mark 1, Mark 2, Mark 4, Mark 5, and Mark 6 of the second generation new concept glove. Small quantities of each prototype design have been produced for the purpose of evaluating the effects of the design modifications on objective and subjective performance measures.

The Mark 1 through Mark 5 prototypes were produced at DREO through a dipping process. They were made of a natural rubber dipped in vulcanized latex. All prototypes were produced in only one size. An approximate glove thickness for these prototypes was 0.47 mm (18.7 mil).

The liners used with the Mark 5 prototype in the third session were made from thermax (a polyester produced by Dupont Canada Limited). These liners were string knit and seamless. They were approximately 1 mm in thickness, with ribbed cuffs and were available in one size only.

The Mark 6 prototype was made from a natural rubber dipped in a vulcanized latex, similar to the Mark 1 through Mark 5 prototypes. It was also made from a bromobutyl rubber through a compression molded process. The bromobutyl mark 6 glove represents a glove which is protective against CW agents. This glove was tested with and without a liner. A string knit liner made from an acrylic-viscose-lycra was used. The liners were available in three sizes : small, medium and large. They had ribbed cuffs and were approximately 1 mm in thickness.

1.1.2 Standard Manual Dexterity Test Protocol

A standard manual dexterity test protocol was developed at the outset of the second generation new concept glove evaluations. This test protocol and its development have been described in detail in an earlier report (Weihrer & Rhodes, 1991). The standard test protocol has been applied in four separate test sessions since 1989. The first test session investigated bare hand performance and performance with the Mark 1 prototype. This session was completed in November 1989. The second test session investigated performance of the Mark 2 and Mark 4 prototypes, and was completed in November 1990. The third test session investigated performance with the Mark 5 prototype and the Mark 5 prototype worn with a liner. This test session was completed in December 1990. The results of these three test sessions have been presented in a previous report, (Weihrer & Rhodes, 1991).

Great effort has been made to consistently apply the standard test protocol (Weihrer & Rhodes, 1991) across the test sessions in order to enable valid comparison of the performance measures between the second generation prototypes. However, it has been necessary to modify the protocol somewhat to accommodate various changes in the experimental conditions of the test sessions. For example, the number of dexterity tests that could be included in any test session was ultimately limited by the number of hand wear conditions that were evaluated within the session.

Another change in the current test protocol was the exclusion of the Grooved Pegboard Assembly Test which was used in the evaluation of the Mark 1 through 5 prototype gloves (Weihrer & Rhodes, 1991). Since the results proved to be somewhat inconsistent and did not differentiate between the gloves, the Pegboard test was excluded from this present study of the Mark 6 prototype.

The subjects who participated in the first test session, where the Mark 1 prototype and bare hand conditions were evaluated were not screened for hand size. This shortcoming was corrected in subsequent test sessions by identifying a size category which corresponded to the size of the prototypes (ie., the "regular-large" size category from a nine size system developed by Robinette & Annis in 1986). Using the key dimensions of this category, subjects were selected to participate in the study. The key hand dimensions specified for this size category are: Hand Length between 18.4 cm and 20.3 cm, and Hand Circumference between 20.3 cm and 22.2 cm.

In addition to incorporating screening for hand size, the questionnaire used to collect the subjective information on the fit, function, and comfort of the prototypes has been modified. Modifications were made to the questionnaire such as improvements of the descriptors and response rating system employed for certain questions.

1.2 Purpose of Current Study

The purposes of this investigation were to evaluate the Mark 6 prototype of the new concept glove design in manual dexterity tasks and subjective measures, and to compare the performance of the Mark 6 prototypes to previous prototypes. The Mark 6 prototype was produced from a natural Latex, similar to the previous second generation prototypes, in order to allow comparisons of the effects of design changes on performance between these prototypes. Limited quantities of a compression molded bromobutyl rubber version of the Mark 6 prototype were made to generate performance measures of the design made from a material with protective qualities which may be similar to that eventually used for the NBC glove. The Mark 6 prototype was evaluated with and without a liner, since the protective glove may eventually be worn either way. Therefore the report represents the results of dexterity testing and subjective measures of fit for four hand wear conditions:

- Bare Hand
- Latex (Mark 6 natural latex without a liner)
- Molded (Mark 6 bromobutyl rubber **without** a liner)
- Molded+Liner (Mark 6 bromobutyl rubber **with** a liner)

Recommendations for further new concept glove design modifications and investigations are also presented.

1.3 Experimental Design

1.3.1 Test Selection Summary

The dexterity test battery for the evaluation of the new concept glove prototypes included the following laboratory tests:

- The Minnesota Rate of Manipulation Test
- The O'Connor Fine Finger Dexterity Test
- The Cord Manipulation and Cylinder Stringing Test
- The Magazine Loading Test

These four tests were chosen because: (a) they have been proven to be sensitive to different glove types; (b) they cover a wide range of materials, objects, and activities, and thus they are not redundant; and (c) they have been proven repeatable in past research. Descriptions of each of these manual dexterity tests are outlined in **Table 3-1** and presented in greater detail in Appendix A.

1.3.2 Control for Learning Effects

Based on the material presented in the background section of this report (1.1) it was apparent that the amount of and organization of practice, prior to the actual trials, was a critical issue with respect to controlling for the effects of learning on performance. The experimental design for the dexterity test battery has been structured so that all trials for a particular test are completed on

one day. In addition, the following practice trial guidelines (Ervin, 1988) incorporated into the second generation glove testing protocol were adhered to in this present study:

1. A minimum of six practice trials should be performed for each dexterity test that will be used during a particular test session (eight trials per handwear condition were completed in the current study).
2. Of the six practice trials, at least two practice trials with each hand wear condition should be performed.
3. Practice trials with the various hand wear conditions should be structured so that the easiest condition is practiced first and the most difficult condition is practised last.
4. **All** practice trials for **all** of the dexterity tests used in a particular test session should be completed **before** any actual trials are performed.

Another feature of the experimental design that is essential to controlling for the effects of learning on performance is the randomization of the tests and hand wear conditions during the actual trials. This randomization should be such that the subject completes all of the actual trials for **one test in one of the hand wear conditions** and then completes all of the actual trials for another test in another hand wear condition, and so on (Ervin, 1988). The order in which the tests and hand wear conditions are presented to each subject should be determined randomly (Ervin, 1988).

1.3.3 Scoring Method

The scoring method used by Johnson et al. (1987) varied depending on the resultant analysis that was performed. Test scores were presented as the mean of the last 4 out of 10 trials performed by a subject. In the analyses of variance, the scores from the trials were analyzed in three groups: (a) the mean of all trials, (b) the mean of the first five trials, and (c) the mean of the last five trials. In order to simplify the analyses and the interpretation of results, the scoring method used by Robinette et al. (1986) and Ross and Ervin (1987) has been incorporated into the experimental design of both this study and the previous study by Weihrer & Rhodes (1991). Using this method, three actual trials were performed for each dexterity test and each hand wear condition (following the completion of all practice trials). The first of these actual trials was used to reacquaint the subject with the test; the score for the test was then the mean of the final two actual trials. An average score was used for the purpose of protecting against anomalous scores (Ross & Ervin, 1987). Therefore, there was only one score for each subject in each test and hand wear condition (refer to the sample data sheet in **Appendix D**). It should be noted that this type of scoring method assumes that learning is essentially complete by the last two trials. Thus, the number of and the structure of the practice trials is very important.

1.3.4 Hand Anthropometry

Anthropometric measurement of the hand has been a component of several dexterity test batteries (Johnson et al., 1987; Robinette et al., 1986; Ross & Ervin, 1987). In the studies by Robinette et al. (1986) and Ross and Ervin (1987) the anthropometric measurements were performed: (a)

to verify the representativeness of the subjects with respect to hand size, and (b) to identify any unusual size or proportion that may have caused misleading results. The prototype gloves evaluated by Johnson et al. (1987) and Weihrer & Rhodes (1991) were only available in one size. Therefore, the anthropometric data gathered in the study proved to be very useful in qualifying the comments from the subjects concerning glove fit.

Anthropometric measures of the hand should provide useful information for assessing the fit of the glove, and for determining whether or not glove fit influenced performance in the dexterity tests. The measurement of hand length is one that is very common in hand anthropometry. Therefore, this measurement has been included in the protocol to provide a basis of comparison between studies. Digit length measurements have been included because they may enable an assessment of the fit of the glove in terms of finger length. This is considered a valuable assessment because manual dexterity may conceivably be significantly affected by excess glove finger length (loss of ability to pick up, to pinch, and/or to feel), and by a shortage of glove finger length (loss of finger and hand mobility). Crotch height measurements have been included because they may enable an assessment of the fit of the glove in terms of palm length. Improper fit in this area may conceivably affect manual dexterity. For instance, if there is an excess or a shortage of glove palm length, the glove finger length may consequently be distorted. Tightness in the palm of the glove may conceivably restrict the mobility of the hand and it may also increase the level of hand fatigue experienced when performing manual dexterity tasks. Conversely, an excess of material in the palm area may reduce the functional effectiveness of the glove because of its increased bulk. Four hand breadth and circumference measurements have been included because they may enable an assessment of the fit of the glove in the palm area. Descriptions of each of these 14 measurements are presented in **Appendix B**.

1.3.5 Questionnaires

The user perspective is important in product design. For this reason, subjects were asked to respond to questions on the different glove systems (see Appendix G for sample questionnaires). The questionnaire has evolved from a single rating of overall fit used in the Mark 1 prototype testing to the 19 questions used currently. This version of the questionnaire was first used successfully in the Functional Fit Evaluation of the CW Glove by Weihrer & Rhodes (1992). The questions addressed overall fit, individual digit length, digit circumference, thumb and finger crotch height, and overall glove comfort and function. A similar questionnaire was administered for the liner alone.

2.0 METHODOLOGY

Two different models of the Mark 6 new concept NBC protective glove were developed and produced (in small quantities) at DREO based upon results and recommendations from the Weihrer and Rhodes study (1991). The design of the two models was the same, though the glove material differed. The first glove was produced in the same fashion as the previous prototypes, through a dipping process from natural **latex**. The second glove was produced through a compression **molded** process from bromobutyl rubber. The molded glove may eventually be used with a liner, therefore the **molded** rubber glove was tested **with and without a liner**. Therefore a total of four hand wear conditions were tested in one session. Four manual dexterity tests were performed in each of the four hand wear conditions. The selection and development of these tests has been explained in detail in Weihrer & Rhodes (1991) and are summarized in **Table 2-3** in section 2.3. **Appendix A** also contains a more detailed description of the manual dexterity tests.

Fourteen hand dimensions were measured at the beginning of each test session. When all trials in a particular hand condition were completed, a questionnaire concerning the glove's comfort, fit and function was administered. **Table 2-1** summarizes the experimental design used for this study. All testing took place at the Cartier Square Drill Hall in Ottawa.

Table 2-1 : Experimental Design for Evaluation of the Mark 6 NBC Glove

	Bare Hand	"Latex" Glove	"Molded" Glove	"Molded + Liner"	Liner
Anthropometry	✓				
Minnesota	✓	✓	✓	✓	
O'Connor	✓	✓	✓	✓	
Cord & Cylinder	✓	✓	✓	✓	
Magazine	✓	✓	✓	✓	
Questionnaire		✓	✓	✓	✓

2.1 Subjects

A total of 15 healthy male subjects participated in the dexterity testing. All subjects were recruited from the Governor General Footguard militia unit operating at the Cartier Square Drill Hall. Each subject was tested individually. Approximately four hours were required to complete a test session with a subject. The age of subjects ranged from 17 years old to 31 years old.

In order to participate in the investigation each subject was required to sign an informed consent form. The consent form that was used is presented in **Appendix C**.

2.1.1 Subject Screening

Screening was conducted during subject recruitment in attempt to obtain a homogeneous group of subjects. Since only one size of glove was produced, subjects had to be chosen whose hands would fit reasonably well in the gloves. Simular to the Mark 5 prototype, the Mark 6 prototype design was based on the key design dimensions specified for the regular-large size of the *Nine-Size System for Chemical Defense Gloves* developed by Robinette & Annis in 1986. Therefore, only subjects with hand lengths[1] between 18.4 cm and 20.3 cm, and hand circumferences[1] between 20.3 cm and 22.2 cm were used, since these dimensions corresponded to the *Regular-Large* size category from the nine-size system. (Robinette and Annis, 1986).

2.2 Hand Wear Conditions

A total of four different hand wear conditions were evaluated (see Table 2-2). A Bare Hand condition was used in order to collect baseline performance values. In order to allow comparison of the latest design to previous prototypes, the Mark 6 glove was produced from **latex**. The latex glove test results can suggest benefits or liabilities of any new modifications in the design of the Mark 6 prototype since the previous prototypes were similarly produced from a natural latex. The third condition was a compression **molded** bromobutyl rubber glove. This material and manufacturing process is most similar to that which may be used for the actual protective glove. The last condition is the **molded** glove **plus** a knit **liner**. In the field, the NBC glove may to be used with a liner.

The major differences between the various second generation new concept glove prototypes gloves are outlined in Table 2-2. The underlying reasons for these design differences are presented below[2]:

1. The angle between digits one and two was approximately 15 degrees larger for the Mark 4, Mark 5, and Mark 6 prototypes, in comparison to the Mark 1 and Mark 2 prototypes. This modification was incorporated because subjects reported substantial thumb fatigue during performance of the manual dexterity tests when the Mark 1 gloves were worn; and this fatigue was attributed, in part, to the small angle between the thumb and digit 2.

2. The characteristics (depth and height) of the area over the ball of the thumb varied between the glove prototypes. Increased space in this region of the hand was considered important for thumb mobility (Johnson et al., 1987). However, the shape required for good mobility was unknown; therefore, a number of different shapes were investigated. The size of the area over the thumb was reduced somewhat for the Mark 6 prototypes.

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[1] Refer to Appendix B for a description of the hand dimension measurement procedures.

[2] Refer to Appendix B for a description of the landmarks and terminology used to reference various features of the hand.

3. The circumferences of the digits varied between the glove prototypes. The Mark 5 and mark 6 prototypes were designed using a number of the dimensions from the *Regular-Large* category from the report by Robinette & Annis (1986). As such, circumferences across the five digits were different for these prototypes. All previous glove prototypes had equal circumferences for digits two through five.

4. The length of the digits also varied between the glove prototypes. The Mark 1 and Mark 2 prototypes had similar digit lengths, while those for the Mark 4 prototype were slightly longer. This change in length resulted from modification of the shape of the fingertips of the glove. The changes apparent in the digit lengths for the Mark 5 prototype were incorporated to model the size of the glove after the *Regular-Large* size described previously. The Mark 6 prototype had the same digit lengths as the Mark 5 prototype.

5. The shape of the glove fingertips also varied between the prototypes. The fingertips of the Mark 1 and Mark 2 prototypes were considered too tapered, that is, their ends were fairly pointed. The Mark 4 and Mark 5 prototypes were modified to reduce this fingertip taper in an attempt to more closely model actual fingertip shape. The Mark 6 prototypes have been modified further to make them slightly more tapered than the Mark 4 and Mark 5 gloves, but not as pointed as the Mark 1 and Mark 2 prototypes.

6. The Mark 5 and Mark 6 prototypes were designed to be worn with a glove liner of approximately 1 mm in thickness. At the beginning of each test session, the subject chose from three liner sizes (small, medium, large) the liner size which he felt provided the best fit. This size of liner was used consistently throughout the test session.

Table 2-2 : Major Features of Comparison Between the New Concept NBC Glove Prototypes

Dimensions	Mark 1	Mark 2	Mark 4	Mark 5	Mark 6†	
Angle Between Digit 1 and Digit 2 (degrees):						
	32	32	45	45	45	
Size of Area Over Ball of Thumb (cm):						
Maximal Depth	5.55	4.65	3.40	5.05	4.0	
Maximal Length	9.45	5.40	6.80	4.00	3.5	
Breadth	??	??	??	??	5.5	
Digit Lengths (cm):						
Digit 1	6.0	6.1	7.0	6.2	6.2	
Digit 2	7.0	7.2	8.0	7.6	7.6	
Digit 3	8.3	8.5	9.2	8.6	8.6	
Digit 4	8.0	8.2	8.9	7.8	7.8	
Digit 5	6.0	6.0	6.7	6.4	6.4	
Finger Tip Shape :						
	Pointed	Pointed	Blunt	Blunt	Tapered	
Height from Crotch 1 (cm):						
Digit 2 Tip	11.4	11.3	12.9	13.5	12.5	
Crotch 2	4.4	4.1	4.9	5.9	4.9	
Crotch 3	4.4	3.9	4.9	5.9	4.9	
Crotch 4	3.6	3.5	4.2	5.0	4.0	
Maximal Circumferences (cm):						
Palm	22.15	22.00	23.10	22.80	22.80	
Digit 1	7.80	8.00	7.90	8.00	8.00	
Digit 2	6.95	6.95	7.25	7.00	7.00	
Digit 3	6.95	6.95	7.25	7.15	7.15	
Digit 4	6.95	6.95	7.25	6.80	6.80	
Digit 5	6.95	6.95	7.25	6.00	6.00	
Wrist	??	??	??	??	21	
Thickness (mil):						
	18.7	18.7	18.7	18.7	23.4	41.6 *

† - These figures were based on reported changes to the Mark 5 design based on recommendations made in Weihrer & Rhodes (1991); that is they were not actually measured.

* - This measurement refers to the bromobutyl rubber molded prototype, not the latex prototype.

2.3 Dexterity Tests

Four different manual dexterity tests were performed by each subject: the Minnesota Test, the O'Connor Test, the Cord Manipulation Test, and the Magazine Loading Test. A summary of general characteristics of these tests is presented below in **Table 2-3**. These tests have been previously discussed in Weihrer & Rhodes (1991). Detailed instructions for the administration of each test are provided in **Appendix A**.

Table 2-3 : Summary of Dexterity Test Characteristics

Test	Hand Involvement	Body Position	Material/Shape	Scoring Method	Activities Involved
Minnesota	Both Hands	Standing	Wooden Cylindrical Blocks	Completion Time	Grasping objects, lifting, turning, transferring between hands, & replacing
O'Connor	Dominant Hand	Seated	Thin Metal Pins	Completion Time for 2 Rows	Grasping fine objects, lifting, & fitting into holes
Cord & Cylinder	Both Hands	Seated	Cord & Plastic Cylinders	Completion Time	Grasping soft objects, squeezing, fitting & pulling
Magazine	Both Hands	Seated	Metal Rounds & Plastic Magazine	Completion Time for 20 Rounds	Grasping objects, lifting, holding, placing, & pushing

2.3.1 Dexterity Test Protocol

Each dexterity test session was comprised of two consecutive phases of events: (a) practice trials for all tests in all hand wear conditions, and (b) actual trials for all tests in all hand wear conditions.

2.3.1.1 Practice Trials

The practice trials were structured to optimize the rate of learning. As such, eight practice trials were performed for each dexterity test. During the test sessions, the practice trials for a given test were structured such that two Bare Hand practice trials were performed first. These were followed by two practice trials with the Latex glove, two with the Molded glove and finally the Molded+Liner, always in that order. During the practice trials, the dexterity tests were always performed in the following order: Minnesota, O'Connor, Cord Manipulation, and Magazine Loading.

2.3.1.2 Actual Trials

The actual trials were performed when all of the practice trials for all four dexterity tests had been completed. Three actual trials were performed for each test and each hand wear condition. The order of exposure to the hand wear conditions and to the dexterity tests was randomized for each subject. The randomization of dexterity tests and hand wear conditions was incorporated into the protocol to reduce any residual learning effects and to reduce the effects of boredom and fatigue on performance.

2.3.1.3 Performance Measurement

The time required to complete each manual dexterity test was used as the measure of performance in the test. All dexterity trials (practice and actual) were timed using a hand- held stopwatch. The completion times from the last two actual trials were averaged to generate a score for a particular dexterity test.

All trials for each hand wear condition were also recorded on 8 mm video tape using a Cannon 440 Camcorder. The video recording was used as a back-up to the stopwatch timing of the trials. It was also intended to be used for demonstration of the effects of various glove design features on manual dexterity test performance, if necessary.

2.4 Hand Anthropometry

Anthropometric measurement of the hand was completed prior to manual dexterity trials. In all cases, only the dominant hand was measured. The following 14 dimensions were measured: hand length, hand breadth, hand breadth including thumb, hand circumference, hand circumference including thumb, digit lengths (five in total), finger crotch heights (four in total). All of the measures were made once, all measures were then repeated at least once more to ensure reliability in measurements. The final measure was the average of the two measurements which were within 2 mm of each other. Detailed descriptions of each of these measurements have been presented in **Appendix B**. Measurements were made using a thin flexible metal measuring tape and calipers.

2.5 Subjective Fit Evaluations

Following completion of the last dexterity trial for each of the four glove conditions within a test session, subjects were asked to respond a short questionnaire. The 19 questions of the questionnaire addressed overall glove fit, individual digit length, individual digit circumference, palm circumference, and wrist circumference. Subjects were also asked to rate the extent to which they felt their performance was affected by the glove relative to the Bare Hand Condition. This subjective feedback was collected for the Latex glove condition, the Molded glove condition, and the Molded+Liner condition. As well, a questionnaire was administered to gather subjective information on the fit of the liner itself. A five point rating scale was provided for each question

(refer to sample questionnaire in **Appendix G**). General and specific comments on the gloves were also solicited.

2.6 Analysis of Results

Statistical analyses were conducted using the Number Cruncher Statistical System (Hintze, 1991) software package. A .05 level of significance was used in all analyses.

3.0 RESULTS AND DISCUSSION

The glove testing sessions involved three components: hand measurements, manual dexterity trials, and subjective evaluations of glove and liner fit. The results of each of these components will be presented and discussed separately. Results pertaining to each glove prototype will subsequently be discussed.

3.1 Subjects

Mean general characteristics of the subjects in the test group are presented in **Table 3-1.** All subjects involved in the study were recruited from a militia unit in Ottawa. Two of the subjects were left hand dominant and thirteen were right hand dominant.

Table 3-1 : Descriptive Statistics of General Subject Characteristics (n=15)

	Age (years)	Height * (cm)	Weight * (kg)	Hand Length (cm)	Hand Circumfer. (cm)	Hand Breadth (cm)
Mean	22	179	79	19.30	21.65	8.81
Standard Deviation	4	5	12	0.52	0.77	0.35
Minimum	17	170	64	18.5	20.40	8.16
Maximum	31	191	98	20.55	23.05	9.27

* reported, not measured

3.2 Hand Anthropometry

Hand measurements were made prior to the manual dexterity testing test sessions. The mean values of the hand dimensions are presented in **Table 3-2.** The subjects had been pre-screened for hand size. This screening was effective in providing subjects with similar hand sizes.

3.3 Dexterity Test Results[3]

3.3.1 Assessment of Learning

In designing a dexterity test protocol there is a compromise that must be made between reducing the number of trials performed, to avoid boredom, and increasing the number of trials performed,

[3] Refer to Appendix I for Rata Data

Table 3-2 : Descriptive Statistics for Anthropometric Measurements (n=15)				
Dimension	**Mean (cm)**	**Standard Deviation (cm)**	**Minimum (cm)**	**Maximum (cm)**
Hand Length	19.30	0.52	18.50	20.55
Hand Breadth	8.81	0.35	8.16	9.27
Hand Breadth+Thumb	10.53	0.60	8.89	11.08
Hand Circumference	21.65	0.77	20.40	23.05
Hand Circ. & Thumb	24.89	0.71	23.65	26.25
Digit 1 Length	7.01	0.34	6.54	7.55
Digit 2 Length	7.35	0.26	6.82	7.74
Digit 3 Length	8.23	0.25	7.69	8.67
Digit 4 Length	7.76	0.26	7.19	8.13
Digit 5 Length	6.31	0.27	5.88	6.87
Crotch Height 1	6.15	0.41	5.28	6.79
Crotch Height 2	10.85	0.37	10.35	11.51
Crotch Height 3	10.78	0.42	10.21	11.53
Crotch Height 4	9.63	0.39	9.03	10.31

to maximize the potential for learning. In order to establish that learning was essentially complete by the time the last two trials of each dexterity test were performed, a simple analysis was conducted. This analysis involved inspection of the learning curves for each manual dexterity test and each glove condition. In addition, an analysis of variance was conducted on each dexterity test in order to investigate differences between mean trial times for each hand wear condition (see **Table 3-3**). These analyses revealed that there were no significant dexterity test performance differences between the fourth and fifth trails within a particular hand wear condition. In fact, in all tests except the Minnesota Test, no significant differences existed between the last three (actual) trials.

The specific analysis conducted was a General Linear Model three way analysis of variance (ANOVA) using a Randomized Block Design. For each three-way ANOVA, the dexterity test completion time was the dependent variable. The subject identification number was the independent randomizing factor. The hand wear condition and the trial number were the other two independent fixed factors. Interaction between trial number and hand wear condition was also investigated. In all tests, except the Magazine Loading test, there was no significant interaction

Table 3-3 : Mean Dexterity Test Times (s) Across Trials (n=15)						
Dexterity Test	Trial Number					
	Hand Wear Condition	1	2	3	4	5
Minnesota	Bare	51.05	45.43	42.31	40.18	39.41
	Latex	59.69	56.07	50.35	47.64	47.73
	Molded	71.53	69.34	60.73	57.79	59.76
	Molded + L.	71.01	66.63	64.85	60.51	60.78
	MEAN (n=60)	63.32^{A}	59.37^{B}	54.56^{C}	51.53^{D}	51.92^{D}
O'Connor	Bare	78.55	73.43	67.93	68.93	65.65
	Latex	90.89	89.44	84.28	81.93	79.39
	Molded	105.54	104.47	89.20	88.34	87.49
	Molded + L.	113.26	106.30	98.48	91.03	96.05
	MEAN (n=60)	97.06^{A}	93.41^{A}	84.97^{B}	82.56^{B}	82.15^{B}
Cord & Cylinder	Bare	79.73	64.47	60.28	58.61	57.24
	Latex	104.25	99.88	79.11	78.43	76.62
	Molded	131.61	119.41	102.05	97.51	101.14
	Molded + L.	130.41	123.81	115.42	111.44	103.30
	MEAN (n=60)	110.50^{A}	102.39^{B}	89.22^{C}	86.50^{C}	84.58^{C}
Magazine Loading	Bare	45.76	42.07	39.37	36.80	37.38
	Latex	51.74	53.56	47.21	47.69	45.21
	Molded	57.78	57.78	52.57	51.71	52.93
	Molded + L.	56.65	55.03	52.32	58.13	55.41
	MEAN (n=60)	52.98^{A}	52.11^{A}	47.87^{B}	48.58^{B}	47.73^{B}
NOTE : Means with the same superscript letter code are NOT significantly different (α=.05)						

between trial number and hand wear condition, meaning the affect of the trial was consistent for all hand wear conditions. However, for the magazine loading test, there was a significant interaction between the trial number and hand wear condition. Investigation of the trial by condition plots for this test revealed that the Molded+Liner condition produced fairly consistent

times across all trials, except for a slight decrease in time at trial 3. This trend was statistically different from the other conditions where performance times decreased across the first and second trials, and generally stabilized for the remaining three trials (see **Table 5-3**). The task of pushing the round into the magazine is clearly the most demanding in terms of force requirements, therefore the variation in performance may indicate fatigue. Nevertheless, results clearly demonstrate that learning was sufficiently complete by the fourth trial of each dexterity test.

Given the natural variability of human performance, some change in completion time was expected between the last two trials of each dexterity test. The learning curves that were generated for each dexterity test demonstrated levelling in completion times for the last two trials. These learning curves have been included in Appendix E.

Despite the fact that changes between the final trials are insignificant, some reasons for visible trends in the data can be speculated. Slight decreases in trial five times may be attributable to continued learning. It is believed that subjects would continue improving performance only marginally over further trials if fatigue and motivation were not factors. However, fatigue and frustration could be important factors in performance. Slight increases in completion times, particularly in Molded glove and Molded+Liner conditions could be attributed to such factors as physical fatigue, boredom, and frustration. However, this variability in data is not statistically significant and collectively, indicates that using the five trial testing protocol was ideal for minimizing the effects of the confounding variables.

3.2.2 Comparison of Hand Wear Conditions

In order to establish whether or not there were any significant differences in manual dexterity test performance that could be attributed to the different hand wear conditions, a separate ANOVA was performed for each dexterity test. The mean completion times of trials four and five was used as the performance score for each hand wear condition and each dexterity test. The mean times were analyzed for significant differences between the hand wear conditions for each test using a General Linear Model two-way ANOVA. For each ANOVA, the mean dexterity test completion time was used as the dependent variable, the subject identification number was the independent randomized blocking factor. The hand wear condition was used as the other independent fixed factor. All post hoc tests were performed using Duncan's Mean Comparison Test (α=.05).

Mean test completion times are presented in **Table 3-4**. Significant differences presented in the t a b l e are denoted by separate letter codes. Times with the **same** letter superscript code are **not** significantly different.

The Bare Hand condition, as expected, was consistently significantly faster than all other hand wear conditions. The Latex glove condition was also consistently faster than all other hand wear conditions except the Bare Hand. In two of the tests, the Molded glove without the liner was significantly faster than the Molded+Liner glove condition. These two tests, the O'Connor and the Cord & Cylinder Tests, likely require the finest motor activity relative to the other two tests.

Table 3-4 : Mean Test Completion Times				
TEST	HAND WEAR CONDITION			
	Bare Hand	Latex	Molded	Molded+Liner
Minnesota	43.03^{A}	51.53^{B}	62.99^{C}	64.07^{C}
O'Connor	70.30^{A}	84.43^{B}	93.83^{C}	99.78^{D}
Cord	62.71^{A}	85.97^{B}	108.5^{C}	115.29^{D}
Magazine	39.75^{A}	48.64^{B}	54.18^{C}	55.72^{C}
NOTE : Means with the same superscript letter code are NOT significantly different (α=.05)				

Thus, the significantly slower times found in the Molded+Liner condition may be attributed to increased thickness of the glove and liner combined. This thickness may affect performance in a number of ways, one of the most likely effects being a reduction in tactile sensation. The Minnesota and Magazine Loading Tests may require relatively more gross finger movements, thus the addition of a liner to the Molded glove may not have significantly decreased test performance.

Performance degradation values seem to indicate that design modifications for the Mark 6 prototype had little positive or negative effect on performance (see **Table 3-5**). Changes in the glove material and/or thickness, however, appears to have had a very dramatic effect on performance. The addition of the liner did have an additional performance degradation effect.

Table 3-5 : Mean Performance Degradation Values (%) for NBC Glove Prototypes						
TEST	GLOVE TYPE					
	Mark 6-Dipped	Mark 6-Molded	Mark 6-Molded +Liner	Mark 5 Dipped	Mark 4 Dipped	Mark 2 Dipped
Minnesota	20.8	48.4	52.4	17.9	15.4	16.2
O'Connor	21.2	31.4	39.1	19.6	28.6	23.0
Cord	34.7	73.4	86.3	29.1	40.3	36.6
Magazine	26.3	41.4	52.2	28.9	23.7	20.7
Performance Degradation : % increase in mean gloved completion time over Bare Hand completion time [(mean gloved time - mean Bare Hand time) ÷ mean Bare Hand time X 100%] * SEE NOTE BELOW FOR EXPLANATION OF THE TABLE'S DATA SOURCES AND INTERPRETATION.						

*NOTE: The data for the Mark 2, Mark 4 and Mark 5 prototypes in Table 3-5 was taken from previous studies and from the present study. The validity of the data for purposes of comparison is reduced, though is helpful for understanding the trends. Slight differences in the protocols, the fact that each study included different subjects of different sample sizes, and each were conducted by a different researcher reduces the validity of the comparison. The different sample sizes contributes the greatest influence in reducing comparability.

The information shown in this table represents the performance data which is only one part of the overall evaluation of the gloves. *Subjective measures of comfort and fit are equally as important.* The numbers in the table show very small differences in performance degradtion between the Latex glove types. The largest differences occur between the Latex and the Bromobutyl rubber gloves. The increased degradation shown by the Bromobutyl gloves is expected since these gloves are considerable thicker and less flexible than the Latex gloves.

3.4 Subjective Fit Evaluations

The results of the subjective glove fit, comfort and performance evaluations are summarized in **Table 3-6**. Each of the nineteen questions was analyzed separately. Statistical analysis was performed only on responses for the three glove conditions (Latex, Molded, and Molded+Liner). The liner was not used by itself in the dexterity tests, however, a questionnaire was administered in order to gather information on its fit.

The statistical analyses were performed to determine whether or not there were significant differences between the hand wear conditions in the responses to the questionnaire. Similar to other analyses, a General Linear Model two-way ANOVA - Randomized Block Design was conducted. For each two-way ANOVA, the question response was the dependent variable, the

subject identification number was the independent randomized blocking factor, and the hand wear condition was the independent fixed factor.

The results of the ANOVAs revealed that the hand wear condition did have a significant effect on responses, but only in three of the nineteen questions. To determine between which hand wear conditions there were statistically significant differences, Duncan's Mean Comparison Test was performed on data from these three questions.

It should be noted that the subjective fit ratings for questions 2 through 13 were structured such that a rating of "3" corresponded to the "just right" qualifier. Therefore, "3" was the optimal fit rating. A lower rating corresponded to a "long/loose" fit, while a higher rating corresponded to a "short/tight" fit **(refer to the sample questionnaire in Appendix G)**.

Significant differences were detected in the responses to question 3. Question 3 asked subjects to rate the fit of the length of the glove in digit two (index finger). The responses for the Latex glove were significantly greater than those for the Molded (without liner) hand wear condition. The Latex glove was rated, on average, as fitting between the "too long but acceptable" and the "just right" qualifiers (2.6). While the unlined Molded condition rated, on average, as "too long but acceptable" (2.0). The Molded+Liner condition was rated between these two glove conditions and was not significantly different from either (2.2). In other words, the length of the index finger in the latex glove was perceived to be a slightly better fit in terms of length than the unlined Molded glove.

Question 13, which asked for a rating of the wrist circumference of the glove, also demonstrated significant differences between the hand wear conditions. The Latex condition received an average rating of 2.1, "too loose but acceptable". This rating was not significantly different from the Molded condition (2.5), but was significantly lower than the average rating of 2.9, "just right" received by the Molded+Liner condition. Therefore, subjects generally found that the wrist circumference fit closest to optimal when the molded glove was worn with a liner.

Table 3-6 : Mean Responses to Questions					
QUESTION	GLOVE				
	Latex	Molded	Molded+ Liner*	Liner*	Optimal Response
1 : Overall Fit	2.5	2.4	2.3	2.9	1
2 : Length D1 (thumb)	3.2	3.1	2.9	3.2	3
3 : Length D2	**2.6^{A}**	**2.0^{B}**	**2.2^{A,B}**	3.1	3
4 : Length D3	2.9	2.6	2.6	3.1	3
5 : Length D4	2.8	2.5	2.5	3.1	3
6 : Length D5	2.1	1.9	2.1	3.1	3
7 : Circumference D1	3.0	2.7	2.9	3.0	3
8 : Circumference D2	2.6	2.4	2.7	3.0	3
9 : Circumference D3	2.8	2.5	2.8	3.0	3
10 : Circumference D4	2.7	2.5	2.8	3.0	3
11 : Circumference D5	2.5	2.4	2.8	3.0	3
12 : Circumference Palm	3.1	2.9	3.4	2.9	3
13 : Circ. Wrist	**2.1^{A}**	**2.5^{A}**	**2.9^{B}**	3.1	3
14 : Crotch 1	2.5	2.6	2.6	2.8	3
15 : Crotch 2	2.4	2.8	2.8	2.7	3
16 : Crotch 3	2.7	2.7	2.8	2.8	3
17 : Crotch 4	2.7	2.6	2.8	2.7	3
18 : Performance	**2.8^{A}**	**2.2^{B}**	**2.3^{B}**	-	5
19 : Comfort	3.2	3.3	3.4	4.8	5

Note : Statistically significant differences were only detected in responses to the bolded questions (α=.05, n=15). Different letter code superscripts indicate the means are significantly different, while same letter codes indicate no statistical difference. Liner questionnaire results were not analyzed with the other responses. Question 18 did not apply to the liner.

* n=14

Question 18 did not address glove fit directly. It asked for a rating of the extent to which the subjects perceived that their performance was affected by the glove when compared to the bare hand performance. This question also demonstrated significant differences in responses between the hand wear conditions. The latex condition received an average rating of 2.8, "degraded my performance a little". The Molded condition and the Molded+Liner condition were rated, on average, very close to the "degraded my performance a lot" qualifier (2.2 and 2.3, respectively). Therefore, the subjects perceived the latex glove as degrading performance less than both of the molded glove conditions as compared to bare hand performance. These subjective measures are somewhat consistent with the actual test results in that completion times for Latex glove conditions were consistently faster than all other gloved conditions.

For all other questions, the response ratings between the hand wear conditions were not significantly different. The average responses for these remaining questions are summarized below. Refer to **Table 3-6** for the specific numbers corresponding to the rating scale qualifiers discussed below.

Question 1 : Overall Fit

The average fit of all hand wear conditions was rated well - between the "good" and "neither good nor poor" qualifiers.

Questions 2 to 6 : Digit Length Fit

Most digit lengths of the hand wear conditions received fairly good ratings, except digit 5 (pinky finger) which was rated, on average, as "too long but acceptable". Digit 1 (thumb) length received especially good fit ratings while all others were rated as being slightly long.

Questions 7 to 11 : Digit Circumference Fit

The digit circumference ratings were fairly good for all three hand wear conditions, usually between the "too loose but acceptable" and the "just right" qualifiers.

Question 12 : Palm Circumference Fit

Palm circumference ratings were not significantly different across the three hand wear conditions. Average ratings fell between the "just right" and the "too tight but acceptable" qualifiers.

Questions 14 to 17 : Crotch Height Fit

The average crotch height ratings were very consistent across the hand wear conditions. The crotch positions were rated between the "too high but acceptable" and the "just right" qualifiers.

Question 19 : Comfort Rating

On a rating scale with a rating of "1" qualified as "uncomfortable" and a rating of "5" as "comfortable", the hand wear conditions received average ratings ranging from 3.2 to 3.4 which were not statistically different.

The glove liners generally received good fit and comfort ratings.

3.5 Comments and Observations

During the testing, subjects were encouraged to comment on the fit and performance of the glove prototypes. These comments were noted as well as observations made during the testing. Subjects' comments and their frequency are listed in **Appendix H**.

- A consistent comment was that general and localized hand fatigue was experienced when repeated dexterity trials were performed in gloved hand wear conditions, especially for Molded or Molded+Liner conditions. Fatigue and discomfort was often localized in the thenar muscles (base of the thumb).

- Several subjects commented that perhaps gloves designed to be either left-handed or right-handed may reduce fatigue in the hand.

- Several subjects commented that the textured or ribbed material in the area of the thumb and finger tips could improve gripping ability.

A number of prototype specific comments and observations were also made; these are presented below.

3.5.1 Latex (dipped) Glove

The latex glove performed quite consistently better than the molded gloves. Subjects did not often report fatigue in the hand as a result of the latex glove, while fatigue and pain from the use of the molded gloves were often reported. One draw back of the thinner and more pliable glove design did become apparent at times during the Magazine Loading test. Latex gloves seemed to be prone to getting caught between the round and the lip of the magazine, while this did not seem to occur as often with the molded glove design. As a result, some latex gloves were damaged.

3.5.2 Molded (unlined) Glove

One interesting finding of this study shows that subjective evaluation of index finger length for the Molded glove was significantly longer than the Latex glove. This is peculiar since no other digits showed any statistically significant differences between glove conditions and digit length should have been physically equal between gloves. It may be possible to explain the perceived differences in digit #2 length using several informal observations of task performance. Since the latex was more pliable than the bromobutyl rubber, subjects were able to easily compress excessive material in the finger tips against the finger tip when picking up objects or stringing

cord through a cylinder. The molded glove, however, is stiffer, requiring more force to compress the "baggy" finger tip of the glove. As well, the thickness also reduces tactile sensation, making the tasks even more awkward. The gloves may have indeed been a little too long for those individuals with hands in the "smaller" portion of the "regular-large" range (Robinette & Annis, 1986). Yet this excess length may have been more tolerable in the latex gloves. Since the forefinger is used more often than the other fingers in performing the different tasks, only problems in the forefinger may have been noticed. Alternatively, it may be possible that the gloves were simply designed with excessively long second digits relative to the other digits.

3.5.3 Molded+Liner Glove

Several subjects commented that the liner helped fill out the glove, making it fit better and feel more comfortable. Some may have perceived better performance when using the Molded glove with the Liner. Although slight trends in subjective rating of performance may support their perceptions (2.2 for molded, and 2.3 for Molded+Liner), as a group, the differences in responses are not significant. However, in terms of comfort, the wrist circumference in the Molded+Liner glove was perceived to fit significantly better than both the Molded (unlined) and the Latex glove conditions.

3.5.4 Liner

In general, the liner was well liked in terms of fit and especially comfort. It served to ease the donning and doffing of the Molded glove since it absorbed some of the moisture from the hand. Only one subject chose to wear the medium sized liner, all others chose the large size.

Although not significantly different, responses for crotch height consistently averaged two to three tenths of a rating lower than the optimal score (3.0). This trend may suggest that the crotch heights are a little too high.

3.6 Summary of Test Results

The results from the manual dexterity testing demonstrated that there were dramatically significant differences between the Bare Hand, Latex and the Molded hand wear conditions. The Bare Hand manual dexterity test times were faster than the gloved times. Latex glove conditions produced much faster test completion times compared to the Molded and Molded+Liner conditions. This was supported by subjective ratings of performance degradation for the different glove conditions. As well, performance with the Molded glove alone was significantly better than the Molded+Liner glove for two tests involving very fine finger activities.

4.0 CONCLUSIONS AND RECOMMENDATIONS

The purpose of this investigation was to evaluate the influence of four hand wear conditions on performance in the manual dexterity tasks and on subjective measures of fit, function and comfort. From the data collected and analyzed, several conclusions regarding the Mark 6 prototype can be made.

First, the performance degradation results indicate that the dominant factor affecting performance was the material used to make the prototypes, not glove size or shape.

Second, the use of a liner with the glove made from bromobutyl rubber further impaired performance in some tasks involving the manipulation of very small objects.

Therefore, it is very difficult to draw conclusions about the effect of specific design features of the Mark 6 on manual dexterity prototype since no significant differences in performance degradation were detected between the different Latex prototypes. The results show that there was no significant difference in comfort and fit between the thicker rubber prototype and the latex prototype for most glove dimensions. However, it is important to note that, on average, subjects rated the fit of individual Mark 6 glove dimensions (eg. length of digit 1, palm circumference, etc.) very close to the optimal "just right" qualifier. Overall fit and comfort were rated, on average, as acceptable. Hence, it is possible to conclude that the wearer is more likely to keep the gloves on and remain protected.

Several recommendations for further investigations can been put forth:

1. Performance degradation was dramatic for the molded glove design. As well, pain and fatigue were often reported following test completion in Molded and Molded+Liner conditions. These results may be attributed to a number of factors, such as:

    - increased thickness which reduces tactile sensation, thus, reducing the user's ability to pick up objects and increasing the force required to hold objects;
    - increased material stiffness which increases the force required to perform the tasks;
    - reduced coefficient of friction which reduces the user's ability to pick up objects and increases the force required to hold objects.

2. Extensive investigation into hand anthropometry as it applies to glove and liner design should be initiated. The final designs should take into account important human factors considerations such as female hand dimensions and use of the glove in cold climate.

3. Further manual dexterity tests may be required to assess the effect of various glove design features such as:
    - ribbing (texture) patterns on the finger tips and palm;
    - degrees of bend in gloves (ie. left and right-handed gloves) to minimize digit flexor and extensor fatigue;
    - material thickness alone;

- material stiffness alone;
- material coefficients of static and dynamic friction;
- angles between digits 1 and 2 which minimize thenar muscle fatigue.

4. Hand fatigue itself should be studied in relation to glove design. The larger angle (45 °) between digit 1 and digit 2 in the Mark 6 could be a contributing factor to the fatigue reported in the thenar muscles. The increased stiffness of the material used in the Molded glove means the thumb must overcome a greater resistance in flexion and adduction. It seems that changes in glove design, which are meant to reduce fatigue and pain in a particular muscle or muscle group, result in reported fatigue and pain in the antagonist muscles. Therefore, the ideal glove design will minimize hand fatigue and discomfort resulting from flexion, extension, adduction, abduction, opposition, and reposition.

5. A physical and environmental demands analysis should be performed in the context of NBC protective equipment. Task analysis data should to be obtained which provides sufficiently detailed descriptions of jobs to determine the frequency, duration and criticality of tasks, operations, elements and basic motions.

6. The information provided by the manual dexterity testing should be useful for identifying basic functional problems with the new concept gloves. Because the scope of the activities that can be tested in a laboratory setting is limited, field testing is a necessary component of glove development. The field testing can either involve structured activities or it can be basically unstructured.

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APPENDIX A

DESCRIPTION OF MANUAL DEXTERITY TESTS

INSTRUCTIONS FOR MANUAL DEXTERITY TESTS

General Instructions to Subjects

During this test session you will perform five manual dexterity tests. You will perform each test in two hand wear conditions - bare handed and gloved. Your goal in each test is to complete it as quickly as possible. You will be given three practice trials of each test in each hand wear condition. After all of the practice trials have been completed, you will perform three actual trials for each test in each hand wear condition. The order that you will perform the actual trials will be randomized. The time required to perform each test will be measured. In addition, your performance will be video taped.

1. Minnesota Rate of Manipulation-Turning Test

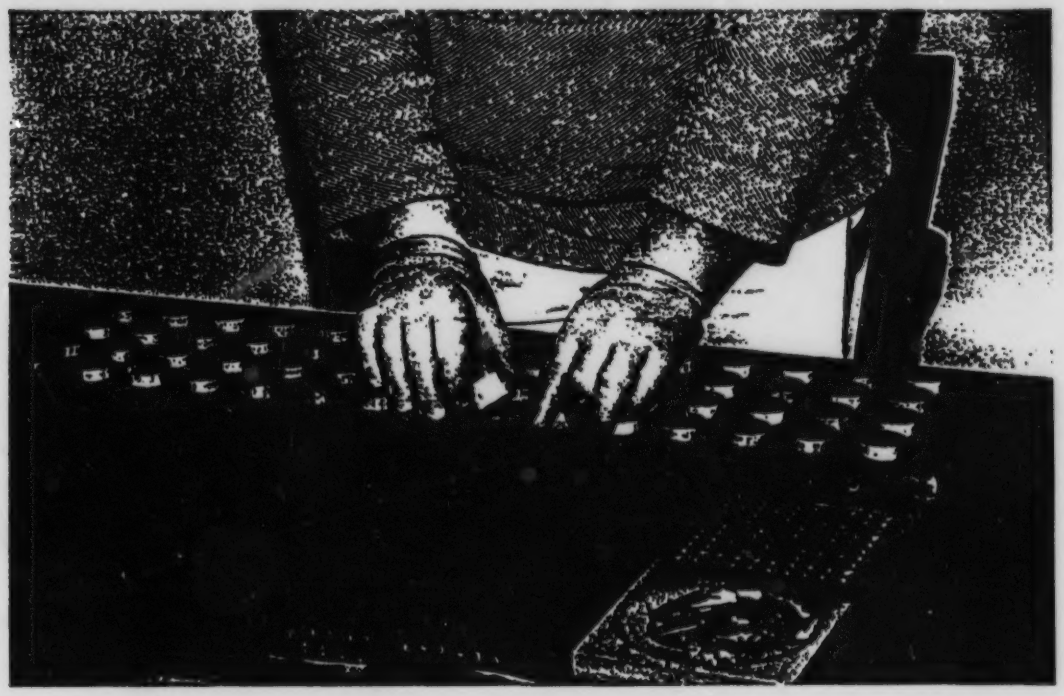


Figure A-1. Apparatus for Minnesota Test.

Instructions for Subjects (Adapted from Robinette et al. (1986))

The objective of this test is to see how quickly all of the blocks on the board can be turned over. You will use both of your hands to perform this task. You will perform this test while standing.

With your left hand, lift the block from the upper right-hand hole and with your right hand put it back, bottom side up, into the same hole (demonstrate). Work across the first row moving from the left to the right. Always pick up the blocks with the leading hand (i.e. left hand for the first row). Work across the second row from the right to the left. For this row your right hand is leading your movement; therefore, pick up the blocks with your right hand and replace them with your left. Continue moving across the rows in this manner until all the blocks have been turned over. Make sure that each block is placed squarely in its hole.

The cue for the start of the test will be "3, 2, 1, GO". Begin the test when you hear the word "GO". You will start the test with your left hand touching the first block. If a block is dropped on the floor during the test, the test will be started over.

Timing Instructions:

Begin the stopwatch at the sound of the word "GO". Stop the watch when the last block is placed and released. (NOTE: practice trials and actual trials are the same length).

2. O'Connor Fine Finger Dexterity Test

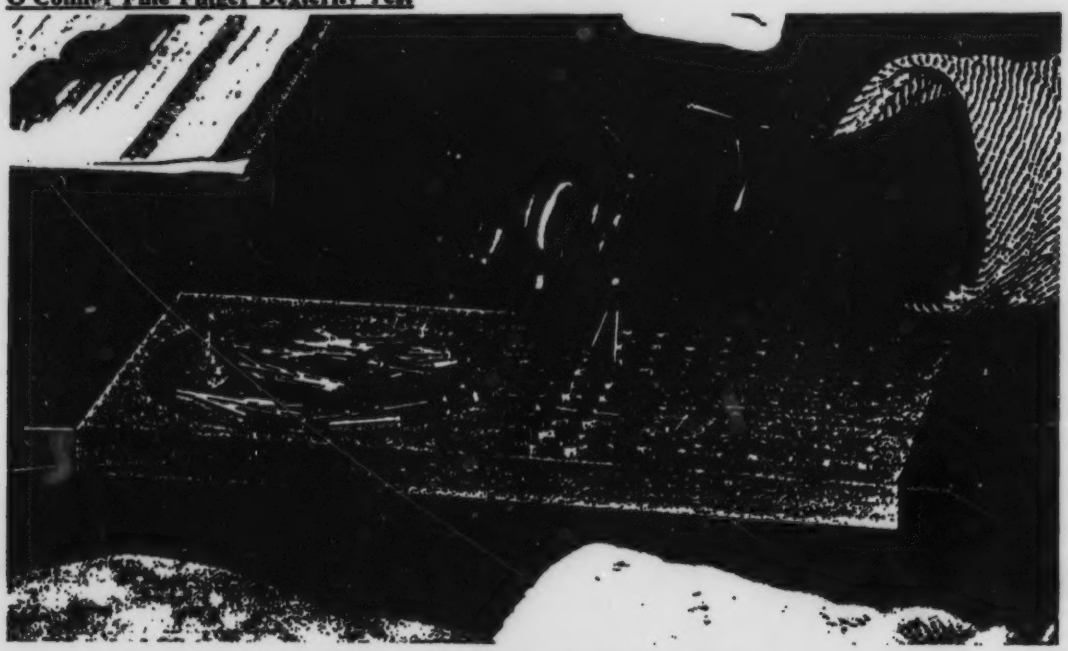


Figure A-2. Apparatus for O'Connor Test.

Instructions for Subjects (Adapted from Robinette et al. (1986))

The objective of this test is to see how quickly two rows of the board can be filled with three pins in each hole. You will perform this test with your dominant hand. Your other hand can be used to stabilize the board. You will be seated while performing this test. The board will be placed on a table in front of you, with the pins at the top of the board.

With your dominant hand, pick up three pins at a time and place them in the hole opposite your dominant hand at the top of the board (demonstrate). Work across the top row filling each hole with three pins. Repeat the procedure for the second row. If you drop one or more pins you may go to the pile to get more (do not try to pick up the pins that have dropped). Once you have placed three pins in a hole do not worry if you knock them out of the hole, continue with the task as if all the pins were still in the hole you already completed.

The cue for the start of the test will be "3, 2, 1, GO". Begin the test when you hear the word "GO". You will start the test with the first set of three pins in your fingers, and with your hand on the table beside the board.

Timing Instructions:

Begin the stopwatch at the sound of the word "GO". Stop the watch when the last hole of the second row has been filled with pins and the pins have been released. (NOTE: practice trials and actual trials are the same length).

3. Cord Manipulation & Cylinder Stringing Test

Figure A-3. Apparatus for Cord Manipulation Test. Instructions for the construction of this apparatus can be found in Cattroll (1983).

Instructions for Subjects (Adapted from Cattroll (1983))

The objective of this test is to see how quickly the loops of cord can be threaded through the plastic cylinders to form a chain. You will perform this test with both hands. You will be seated while performing this test. The belt will be placed on a table in front of you, with the hook on the right side.

The task is performed by elongating the first loop (loop at end of belt opposite to metal hook) and threading it through a plastic cylinder. The end of this loop is opened, above the cylinder, and the next loop is threaded through the opening and then through another plastic cylinder (demonstrate). This process is continued until a complete chain is formed. The final loop, after being threaded through a plastic cylinder, is looped over a metal hook at the end of the belt.

The cue for the start of the test will be "3, 2, 1, GO". Begin the test when you hear the word "GO". You will start the test with both hands resting on the edge of the table.

Timing Instructions:

Begin the stopwatch at the sound of the word "GO". Stop the watch when the last loop is looped over the hook and the hands release the cord and hook. (NOTE: practice trials and actual trials are the same length).

4. Magazine Loading Test

Figure A-4. Apparatus for the Magazine Loading Test

Instructions for Subjects

The objective of this test is to see how quickly rounds can be loaded individually into an empty magazine. Practice rounds for a C7 rifle will be used. There will be 20 rounds in total to be loaded. These will be located in a helmet (suspension system removed) at the beginning of each trial. The helmet may be placed on or between the knees or on the table in front of the seated subject. You will perform this test with both hands. You will be seated while performing this test. The magazine will be held with both hands at the start of the test.

Steps in task:

- pick up a round or a group of rounds from the helmet
- place a round in position on the magazine
- push the round into the magazine (that is, load each round into the magazine individually)

The cue for the start of the test will be "3, 2, 1, GO". Begin the test when you hear the word "GO".

Timing Instructions:

Begin the stopwatch at the sound of the word "GO". Stop the watch when the last round has been pushed into the magazine. (NOTE: Practice trials and actual trials are the same length).

APPENDIX B

HAND ANTHROPOMETRY

B-1 TERMINOLOGY AND LANDMARKS FOR HAND ANTHOPOMETRY

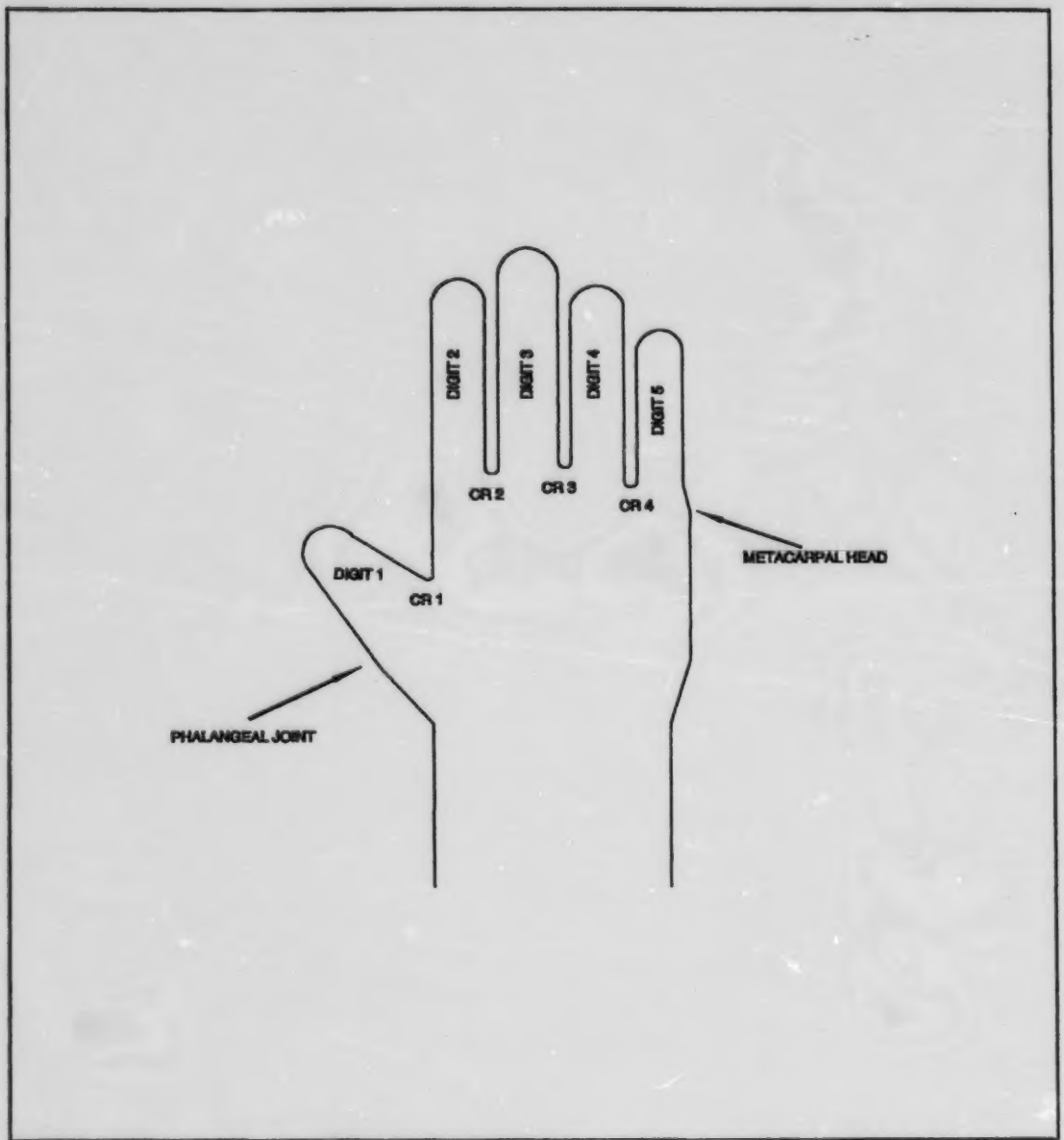


Figure B-1a. Terminology for referencing basic features of the hand (ventral view) (CR = crotch).

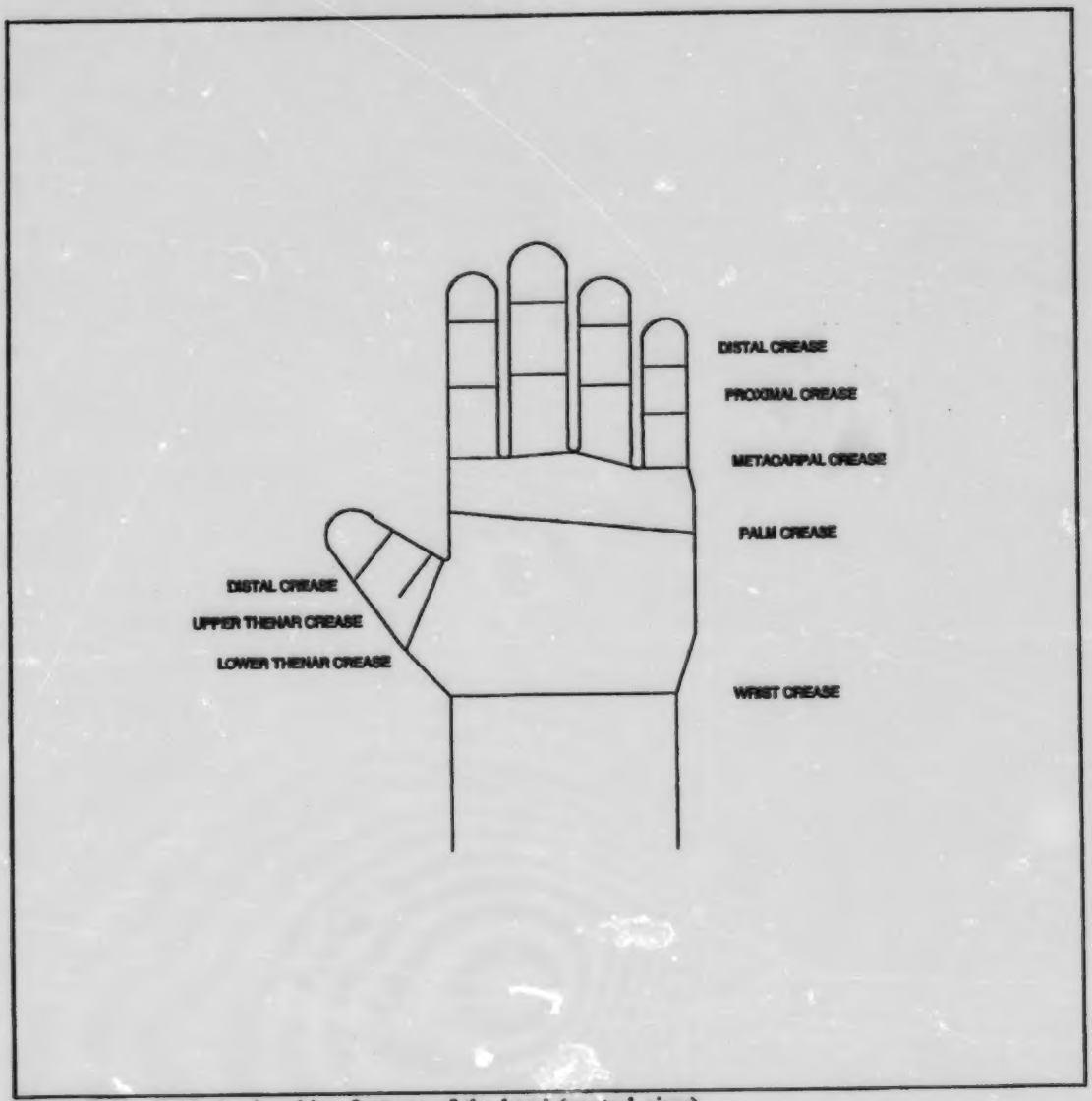


Figure B-1b. Basic landmarking features of the hand (ventral view).

B-2 MEASUREMENT OF METAL HAND FORMS

1 = DIGIT 1 LENGTH
2 = DIGIT 2 LENGTH
3 = DIGIT 3 LENGTH
4 = DIGIT 4 LENGTH
5 = DIGIT 5 LENGTH
6 = CROTCH 1 TO DIGIT 2 TIP
7 = CROTH 2 HEIGHT
8 = CROTCH 3 HEIGHT
9 = CROTCH 4 HEIGHT

Figure B-2. This figure demonstrates the manner in which the digit lengths and the crotch heights were measured on the metal hand forms.

NOTE: All other hand form measurements are self explanatory.

B-3 INSTRUCTIONS FOR HAND ANTHROPOMETRY

General Instructions

Measure the dimensions of the dominant hand only. Make one measurement of each dimension - complete a full round of 14 measurements, then repeat the round of measurements. If any discrepancies exist between the two measurements (i.e. differences greater than 2 mm) then redo the measurement. The actual measurement will be the mean of the two measurements. The length and breadth measurements will be made with a ruler, the circumference measurements will be made with a thin metal measuring tape.

1. Hand Length

Measure the perpendicular distance from the wrist crease (WC) to the tip of the distal phalanx of digit 3 (palmar view, fingers together, and hand flat).

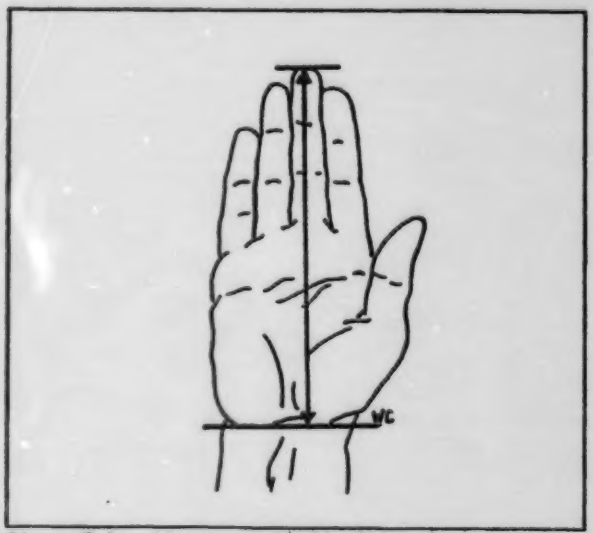


Figure B-3a. Measurement of hand length.

2. Hand Breadth at Metacarpal

Measure the distance from the outside of digit 2 metacarpal to the outside of digit 4 metacarpal, along the crease where the proximal phalanges meet with the metacarpals (palmar view, fingers together, thumb extended, and hand flat).

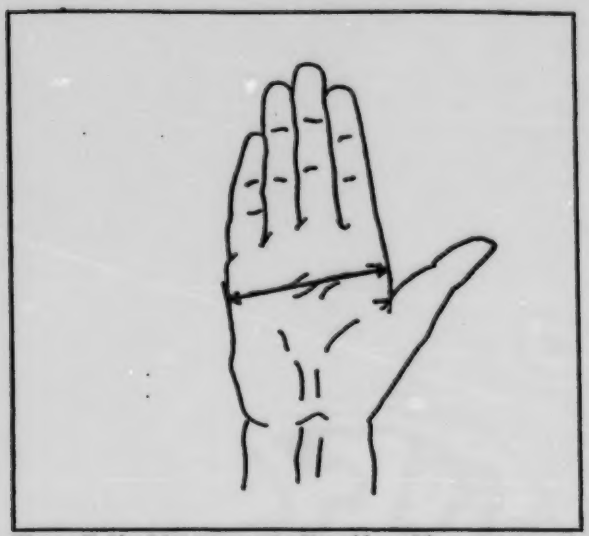


Figure B-3b. Measurement of hand breadth at metacarpal.

3. Hand Breadth Including Thumb

Measure the distance from the outside of the base of the middle phalanx of digit 1 (thumb) to the opposite side of the hand, in a line that is parallel to the WC (palmar view, fingers together, thumb held close to fingers, and hand flat).

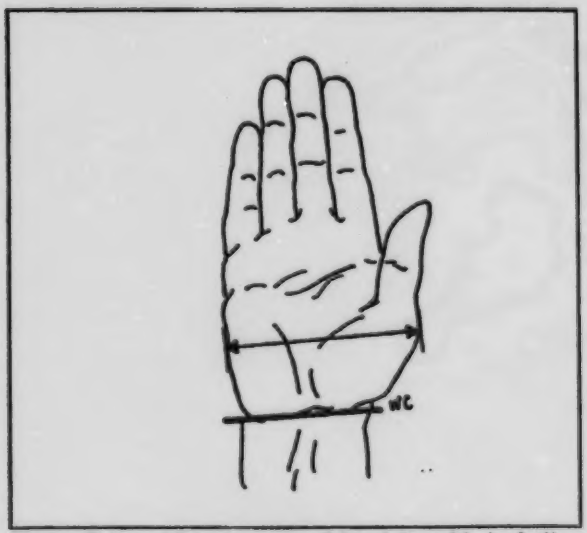


Figure B-3c. Measurement of hand breadth including thumb.

4. Hand Circumference

Measure the circumference of the hand at the point of the metacarpal-phalangeal junction (digits 2 to 4) (dorsal view, fingers together, thumb extended, and hand flat).

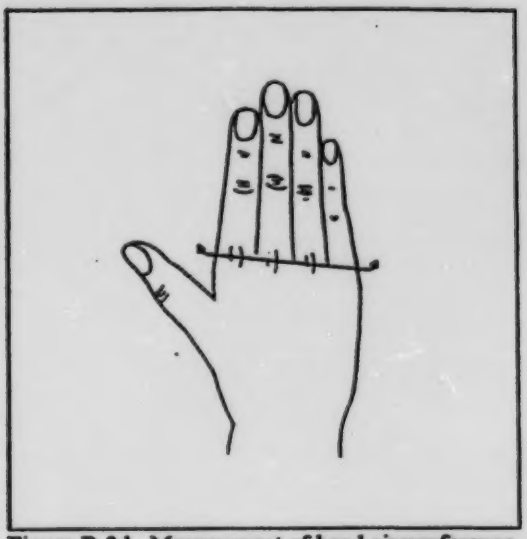


Figure B-3d. Measurement of hand circumference.

5. Hand Circumference Including Thumb

Measure the circumference of the hand, perpendicular to its long axis, at the point of the metacarpal-phalangeal junction for digit 1 (dorsal view, fingers together, thumb held close to fingers, and hand flat).

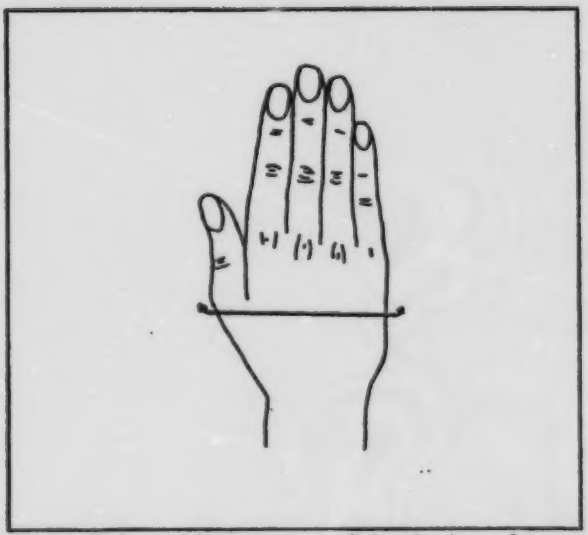


Figure B-3e. Measurement of hand circumference including thumb.

6. Digit Lengths

Measure the distance from the tip of the distal phalanx to the finger crease (FC), along the mid-line of each finger (palmar view, fingers slightly separated, and hand flat).

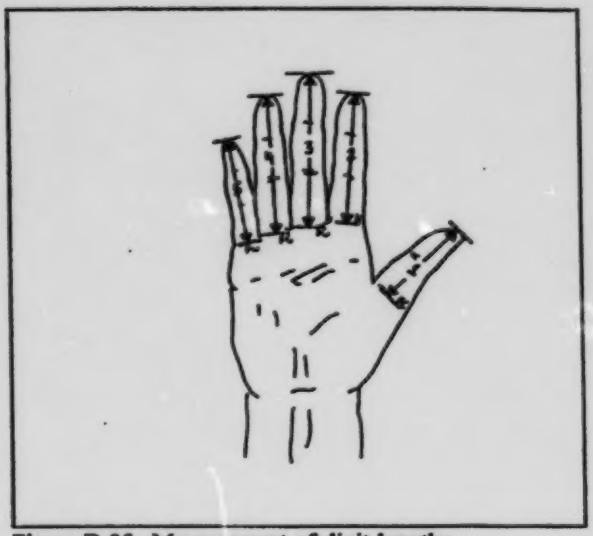


Figure B-3f. Measurement of digit lengths.

7. Crotch Heights

Measure the perpendicular distance from the crotch of each digit to the WC (palmar view, fingers together, thumb extended, and hand flat).

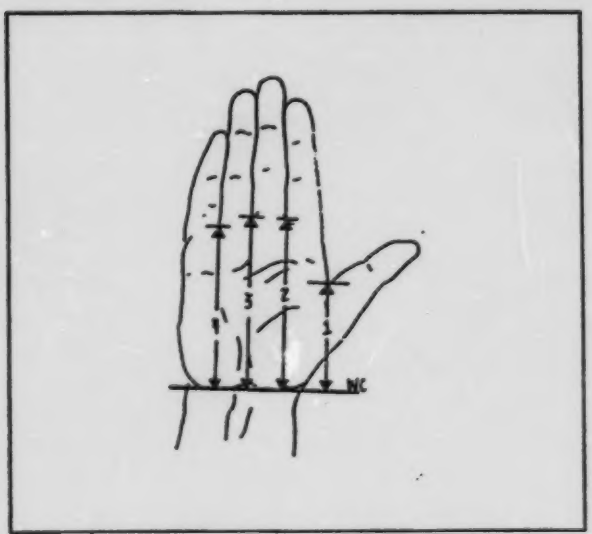


Figure B-3g. Measurement of crotch heights.

APPENDIX C

INFORMED CONSENT FORM

INFORMED CONSENT FORM FOR MANUAL DEXTERITY TRIALS OF NBC PROTECTIVE GLOVES

Description of the Experiment

The purpose of this experiment is to investigate the effect of wearing protective gloves on manual dexterity.

Each participant in the experiment will be involved in approximately four hours of testing. Each subject will be tested individually. During the four hours, four different manual dexterity tests will be performed. Each test requires between one and three minutes to complete. Each test will be performed twice with bare hands, and five times with each of three different types of protective hand-wear. Performance in each test will be timed and videotaped.

The four tests that will be performed are:

1. **Minnesota Rate of Manipulation - Turning Test:** Wooden cylindrical blocks are picked up, turned over, and placed back into the grooved hole they were removed from.

2. **O'Connor Fine Finger Dexterity Test:** Thin metal pins are picked up, three at a time, and placed into holes on a board.

3. **Cord Manipulation Test:** Loops of cord are threaded through small plastic cylinders to make a chain.

4. **Magazine Loading Test:** Twenty 'practice' rounds are loaded individually into the empty magazine of a C7 rifle.

Prior to the manual dexterity trials, fourteen hand dimensions will be measured on the participant's dominant hand . Following the trials the participant will be asked to rate the fit of the protective gloves.

Risks and Precautions

There are no risks to the participants in this experimentation. Some degree of fatigue may be experienced in the muscles of the hands during the performance of certain manual dexterity tests.

However, the experiment has been designed to minimize this hand fatigue by randomizing the order in which the tests are performed. In any case, the fatigue will be transient. The participant may experience some degree of discomfort when the gloves are worn, due to sweat accumulation in the gloves.

Conditions

Each participant will receive $50.00 upon completion of the manual dexterity test session as payment for services performed therein.

Questions concerning the glove testing can be directed to Sylvia Weihrer at (613) 832-1491.

CERTIFICATE OF INFORMED CONSENT

HUMAN PERFORMANCE DEGRADATION ATTRIBUTABLE TO THE NEW CONCEPT NBC PROTECTIVE GLOVE

I, the undersigned, do hereby acknowledge:

- that I have read the attached written description of the protocol that will be used for the protective glove testing; that I have been informed of the possible anticipated risks, and that I understand and accept them.

- my understanding that I may ask any questions or request further explanation or information about the procedures at any time before, during, and after the testing.

- that in the event of any circumstance requiring medical attention, I will rely on the scientist directing the test to arrange for medical attention and to institute whatever measures are considered necessary for my safety and well being.

- that I have freely consented to participate in these tests, without any compulsion or coercion of any kind, and that I understand that I may withdraw from the tests at any time.

- that I hereby release Rhodes and Associates Inc., its agents, officers, and employees from any liability with respect to any damage or injury that I may suffer during the administration of the test protocols, except where the damage or injury is caused by the negligence of Rhodes and Associates Inc., its agents, officers, or employees acting within the scope of their duties.

_____ _____

Signature of Volunteer Date

_____ _____

Signature of Witness Date
(other than the principal scientist).

APPENDIX D

DATA SHEETS

HAND ANTHROPOMETRY - DATA SHEETS

Test Information

Date: _____ Time: _____

Subject Information

Name: _____ Id #: _____

Age: _____ DoB: _____

Ht: _____ Wt: _____

Dominant Hand: _____

Anthropometric Measurements

	Initial Measure	Final Measure	MEAN
Hand Length:	_____	_____	_____
Hand Breadth:	_____	_____	_____
Hd Br + Thumb:	_____	_____	_____
Hd Circumference:	_____	_____	_____
Hd Circ + Thumb:	_____	_____	_____
Digit 1 Length:	_____	_____	_____
Digit 2 Length:	_____	_____	_____
Digit 3 Length:	_____	_____	_____
Digit 4 Length:	_____	_____	_____
Digit 5 Length:	_____	_____	_____
Crotch Height 1:	_____	_____	_____
Crotch Height 2:	_____	_____	_____
Crotch Height 3:	_____	_____	_____
Crotch Height 4:	_____	_____	_____

MARK 6 GLOVE EVALUATION MAR. '93

NAME:
DATE:
TIME:
ID#:

MINNESOTA RATE OF MANIPULATION TEST

WEAR DITION	PRACTISE TRIAL 1	PRACTISE TRIAL 2	RANDOM ORDER	ACTUAL TRIAL 1	ACTUAL TRIAL 2	ACTUAL TRIAL 3	SCORE (MEAN 2 & 3)	COMMENTS
E H.	1	2						
EX	3	4						
ED	5	6						
INER	7	8						

O'CONNOR FINE FINGER DEXTERITY TEST

WEAR DITION	PRACTISE TRIAL 1	PRACTISE TRIAL 2	RANDOM ORDER	ACTUAL TRIAL 1	ACTUAL TRIAL 2	ACTUAL TRIAL 3	SCORE (MEAN 2 & 3)	COMMENTS
E H.	1	2						
EX	3	4						
ED	5	6						
INER	7	8						

CORD MANIPULATION AND CYLINDER STRINGING TEST

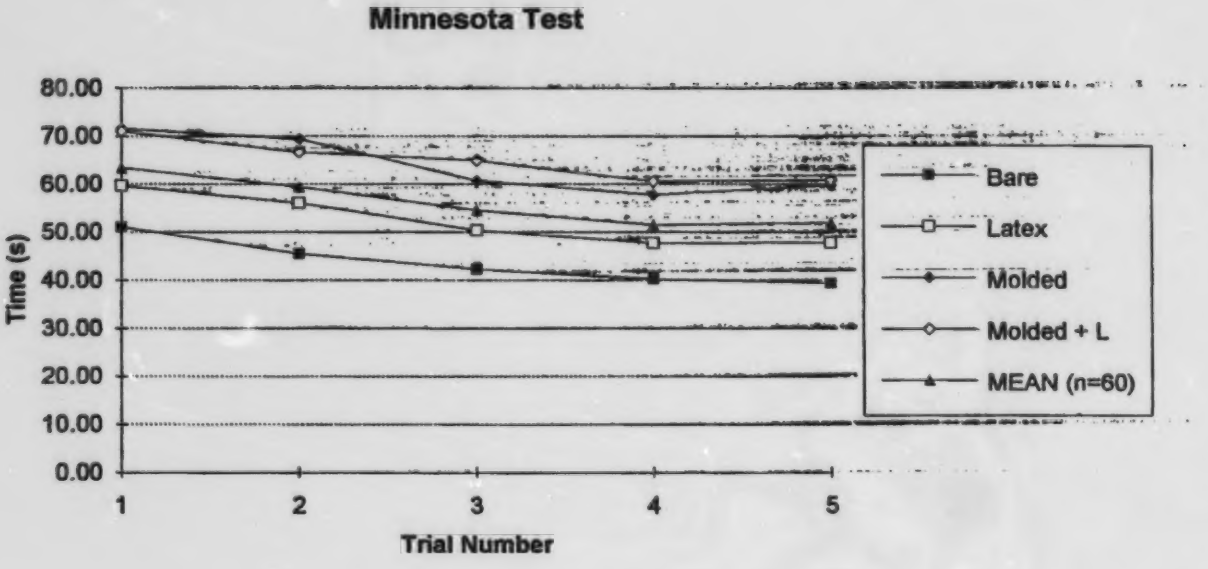
WEAR DITION	PRACTISE TRIAL 1	PRACTISE TRIAL 2	RANDOM ORDER	ACTUAL TRIAL 1	ACTUAL TRIAL 2	ACTUAL TRIAL 3	SCORE (MEAN 2 & 3)	COMMENTS
H.	1	2						
X	3	4						
ED	5	6						
INER	7	8						

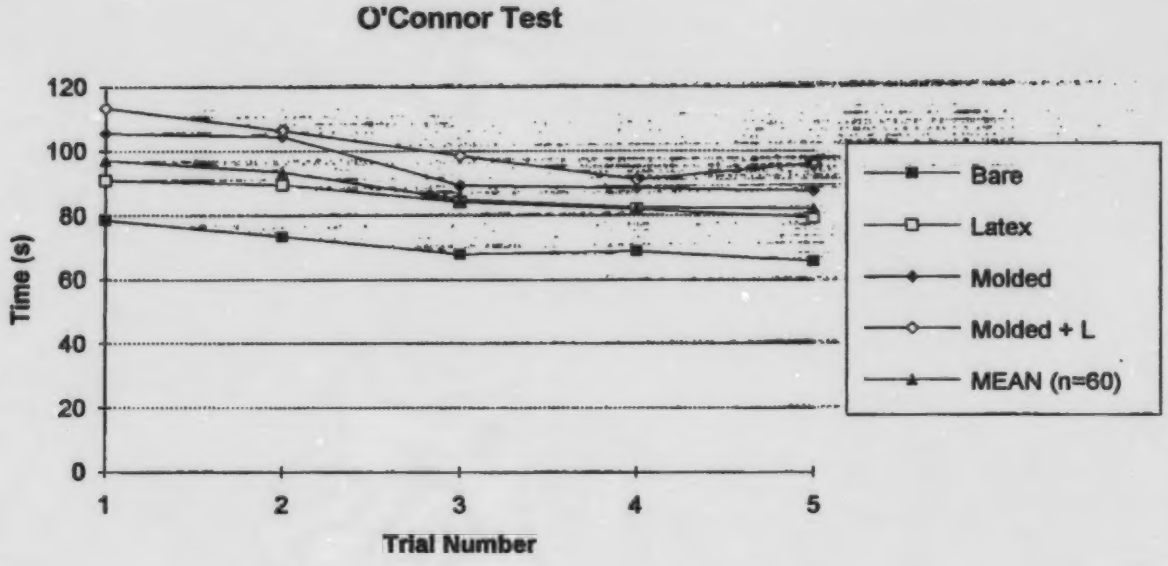
MAGAZINE LOADING TEST

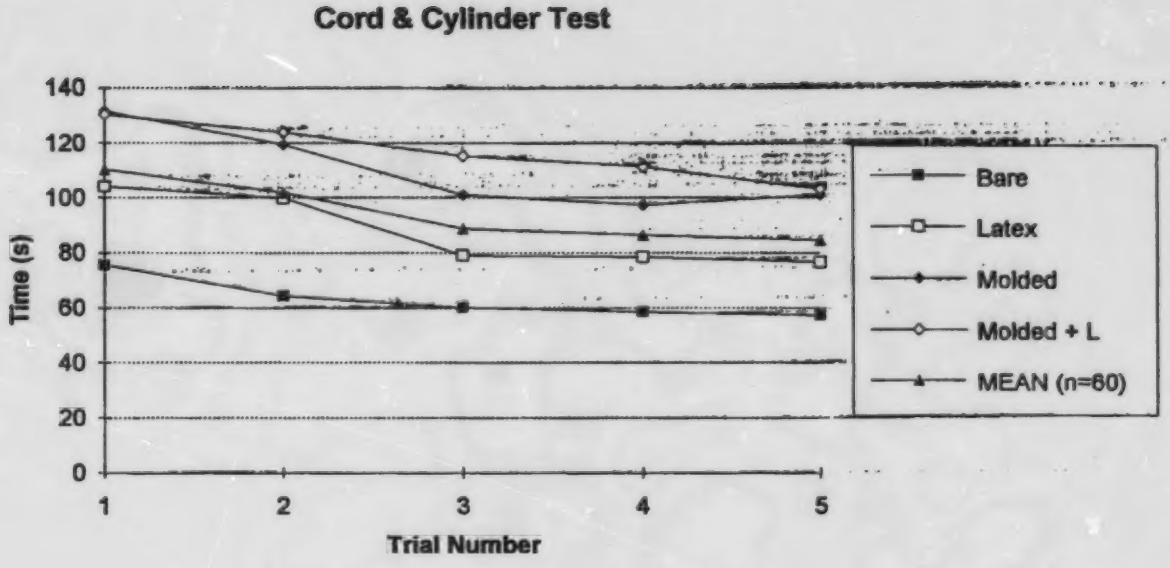
WEAR DITION	PRACTISE TRIAL 1	PRACTISE TRIAL 2	RANDOM ORDER	ACTUAL TRIAL 1	ACTUAL TRIAL 2	ACTUAL TRIAL 3	SCORE (MEAN 2 & 3)	COMMENTS
H	1	2						
X	3	4						
ED	5	6						
NER	7	8						

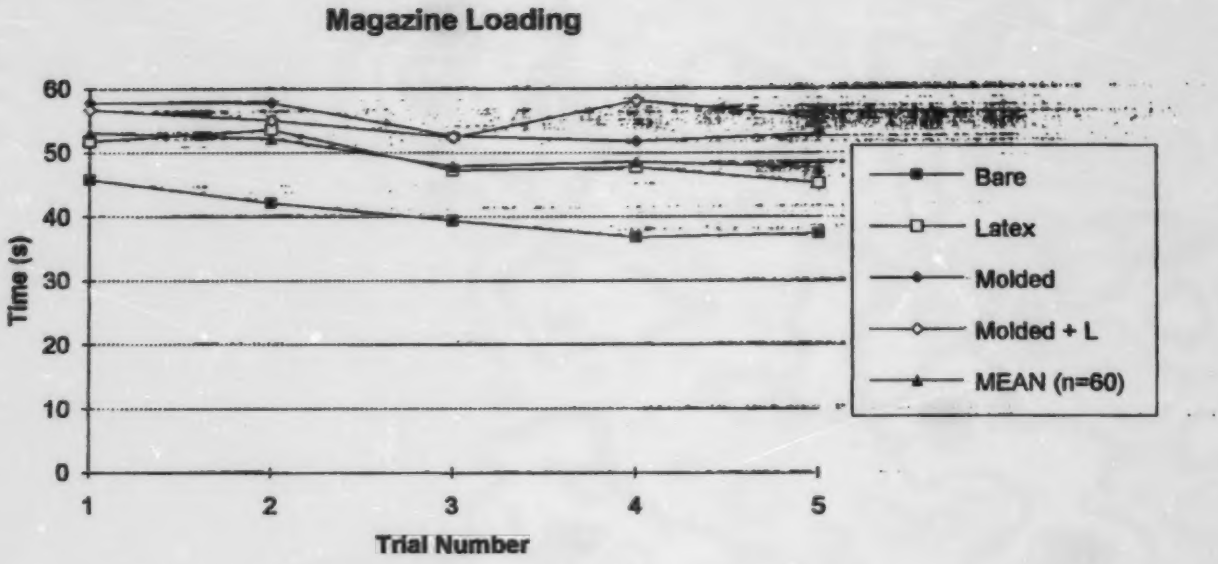
APPENDIX E

LEARNING CURVES


Minnesota Test
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Time (s)
1
2
3
4
5
Trial Number
Bare
Latex
Molded
Molded + L
MEAN (n=60)

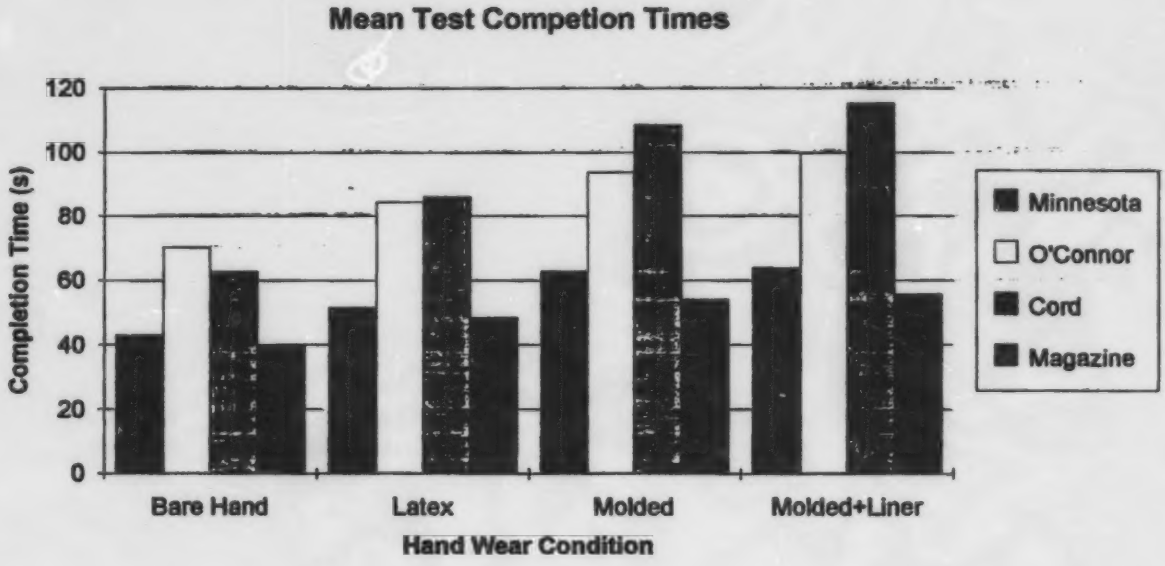

O'Connor Test
120
100
80
60
40
20
0
Time (s)
1
2
3
4
5
Trial Number
Bare
Latex
Molded
Molded + L
MEAN (n=60)

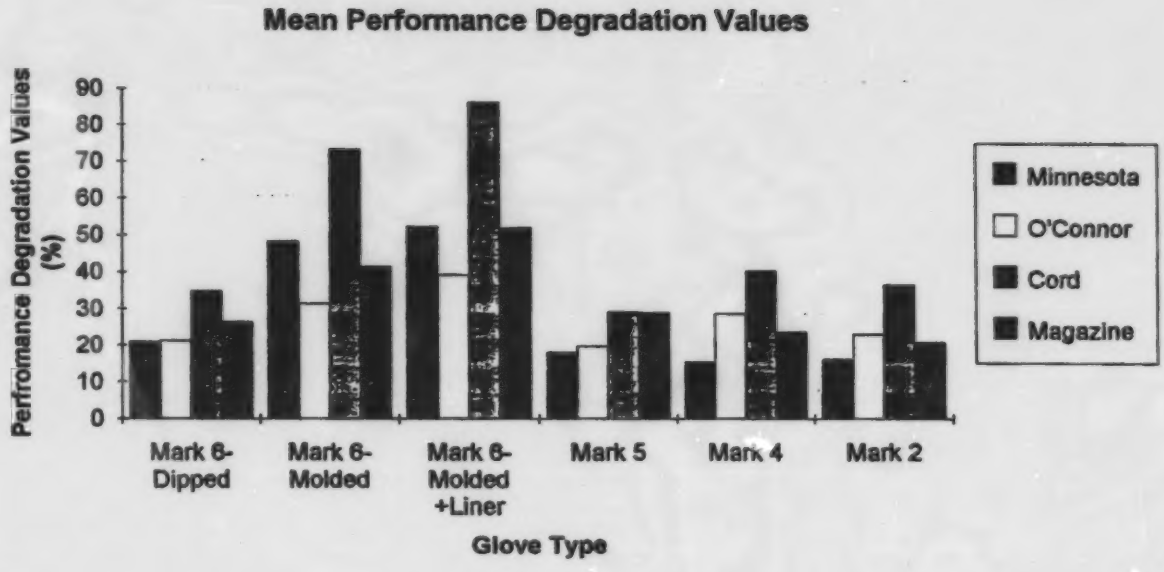

Cord & Cylinder Test
140
120
100
80
60
40
20
0
Time (s)
1
2
3
4
5
Trial Number
Bare
Latex
Molded
Molded + L
MEAN (n=60)


Magazine Loading
60
50
40
30
20
10
0
Time (s)
1
2
3
4
5
Trial Number
Bare
Latex
Molded
Molded + L
MEAN (n=60)

APPENDIX F

GRAPHS OF DEXTERITY TEST RESULTS


Mean Test Competion Times
120
100
80
60
40
20
0
Completion Time (s)
Bare Hand
Latex
Molded
Molded+Liner
Hand Wear Condition
Minnesota
O'Connor
Cord
Magazine


Mean Performance Degradation Values
Perfromance Degradation Values (%)
90
80
70
60
50
40
30
20
10
0
Mark 6-Dipped
Mark 6-Molded
Mark 6-Molded +Liner
Mark 5
Mark 4
Mark 2
Glove Type
Minnesota
O'Connor
Cord
Magazine

APPENDIX G

SAMPLE QUESTIONNAIRES

GLOVE: _____

ID #: _____

DATE: _____

FUNCTIONAL FIT QUESTIONNAIRE

GLOVE

Rate the fit of the glove in the following areas of the hand by circling the number along the scale that corresponds to the most appropriate response.

1. OVERALL FIT:

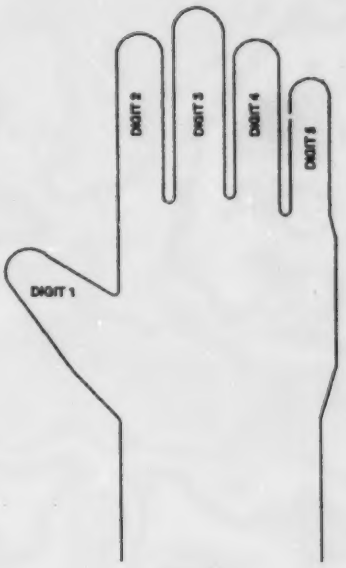
--------1------2------3------4------5--------

VERY GOOD	GOOD	NEITHER GOOD NOR POOR	POOR	VERY POOR

2. DIGIT 1 LENGTH:

--------1------2------3------4------5--------

TOO LONG	TOO LONG BUT ACCEPTABLE	JUST RIGHT	TOO SHORT BUT ACCEPTABLE	TOO SHORT



3. DIGIT 2 LENGTH:

--------1------2------3------4------5--------

TOO LONG	TOO LONG BUT ACCEPTABLE	JUST RIGHT	TOO SHORT BUT ACCEPTABLE	TOO SHORT

4. DIGIT 3 LENGTH:

--------1------2------3------4------5--------

TOO LONG	TOO LONG BUT ACCEPTABLE	JUST RIGHT	TOO SHORT BUT ACCEPTABLE	TOO SHORT

5. DIGIT 4 LENGTH:

--------1------2------3------4------5--------

TOO LONG	TOO LONG BUT ACCEPTABLE	JUST RIGHT	TOO SHORT BUT ACCEPTABLE	TOO SHORT

6. DIGIT 5 LENGTH:

--------1------2------3------4------5--------

TOO LONG	TOO LONG BUT ACCEPTABLE	JUST RIGHT	TOO SHORT BUT ACCEPTABLE	TOO SHORT

7. DIGIT 1 CIRCUMFERENCE:

--------1------—------2------------3------------4------------5--------

TOO LOOSE	TOO LOOSE BUT ACCEPTABLE	JUST RIGHT	TOO TIGHT BUT ACCEPTABLE	TOO TIGHT

8. DIGIT 2 CIRCUMFERENCE:

--------1------—------2------------3------------4------------5--------

TOO LOOSE	TOO LOOSE BUT ACCEPTABLE	JUST RIGHT	TOO TIGHT BUT ACCEPTABLE	TOO TIGHT

9. DIGIT 3 CIRCUMFERENCE:

--------1------—------2------------3------------4------------5--------

TOO LOOSE	TOO LOOSE BUT ACCEPTABLE	JUST RIGHT	TOO TIGHT BUT ACCEPTABLE	TOO TIGHT

10. DIGIT 4 CIRCUMFERENCE:

--------1------—------2------------3------------4------------5--------

TOO LOOSE	TOO LOOSE BUT ACCEPTABLE	JUST RIGHT	TOO TIGHT BUT ACCEPTABLE	TOO TIGHT

11. DIGIT 5 CIRCUMFERENCE:

--------1------—------2------------3------—------4------------5--------

TOO LOOSE	TOO LOOSE BUT ACCEPTABLE	JUST RIGHT	TOO TIGHT BUT ACCEPTABLE	TOO TIGHT

12. PALM CIRCUMFERENCE:

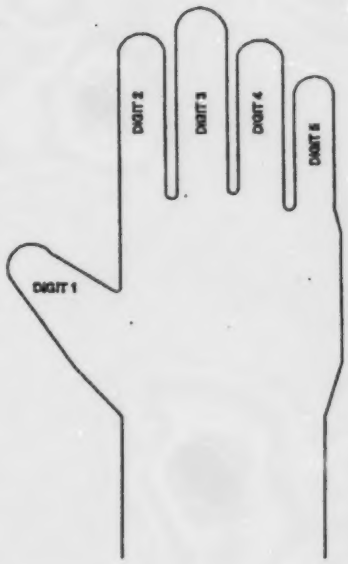
--------1------—------2------------3------------4------------5--------

TOO LOOSE	TOO LOOSE BUT ACCEPTABLE	JUST RIGHT	TOO TIGHT BUT ACCEPTABLE	TOO TIGHT

13. WRIST CIRCUMFERENCE:

--------1------—------2------------3------------4------------5--------

TOO LOOSE	TOO LOOSE BUT ACCEPTABLE	JUST RIGHT	TOO TIGHT BUT ACCEPTABLE	TOO TIGHT



14. CROTCH OF THUMB:

--------1----------2----------3----------4----------5--------

TOO HIGH	TOO HIGH BUT ACCEPTABLE	JUST RIGHT	TOO LOW BUT ACCEPTABLE	TOO LOW

15. CROTCH 2:

--------1----------2----------3----------4----------5--------

TOO HIGH	TOO HIGH BUT ACCEPTABLE	JUST RIGHT	TOO LOW BUT ACCEPTABLE	TOO LOW

16. CROTCH 3:

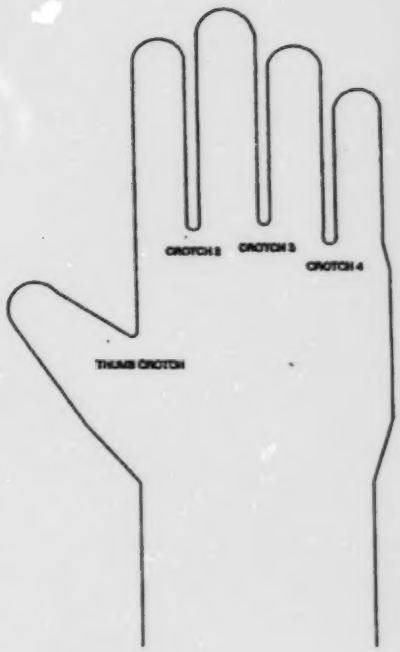
--------1----------2----------3----------4----------5--------

TOO HIGH	TOO HIGH BUT ACCEPTABLE	JUST RIGHT	TOO LOW BUT ACCEPTABLE	TOO LOW

17. CROTCH 4:

--------1----------2----------3----------4----------5--------

TOO HIGH	TOO HIGH BUT ACCEPTABLE	JUST RIGHT	TOO LOW BUT ACCEPTABLE	TOO LOW



18. Rate the extent that <u>you</u> <u>feel</u> your performance was affected by this glove (compared to bare hand performance):

THIS GLOVE:

--------1----------2----------3----------4----------5--------

EXTREMELY DEGRADED MY PERFORMANCE	DEGRADED MY PERFORMANCE A LOT	DEGRADED MY PERFORMANCE A LITTLE	HAD NO EFFECT ON MY PERFORMANCE	ENHANCED MY PERFORMANCE

19. Rate the comfort of this glove:

--------1----------2----------3----------4----------5--------

UNCOMFORTABLE COMFORTABLE

Please feel free to add comments on the fit and function of the glove:

_____

_____

_____

LINER: _____

ID #: _____

DATE: _____

FUNCTIONAL FIT QUESTIONNAIRE

LINER

Rate the fit of the liner in the following areas of the hand by circling the number along the scale that corresponds to the most appropriate response.

1. OVERALL FIT:

--------1----------2----------3----------4----------5--------

TOO LOOSE	TOO LOOSE BUT ACCEPTABLE	JUST RIGHT	TOO TIGHT BUT ACCEPTABLE	TOO TIGHT

2. DIGIT 1 LENGTH:

--------1----------2----------3----------4----------5--------

TOO LONG	TOO LONG BUT ACCEPTABLE	JUST RIGHT	TOO SHORT BUT ACCEPTABLE	TOO SHORT

3. DIGIT 2 LENGTH:

--------1----------2----------3----------4----------5--------

TOO LONG	TOO LONG BUT ACCEPTABLE	JUST RIGHT	TOO SHORT BUT ACCEPTABLE	TOO SHORT

4. DIGIT 3 LENGTH:

--------1----------2----------3----------4----------5--------

TOO LONG	TOO LONG BUT ACCEPTABLE	JUST RIGHT	TOO SHORT BUT ACCEPTABLE	TOO SHORT

5. DIGIT 4 LENGTH:

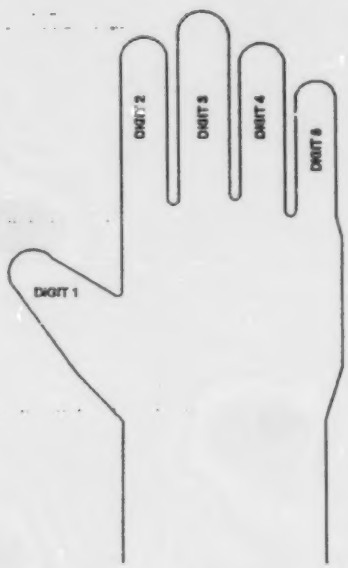
--------1----------2----------3----------4----------5--------

TOO LONG	TOO LONG BUT ACCEPTABLE	JUST RIGHT	TOO SHORT BUT ACCEPTABLE	TOO SHORT

6. DIGIT 5 LENGTH:

--------1----------2----------3----------4----------5--------

TOO LONG	TOO LONG BUT ACCEPTABLE	JUST RIGHT	TOO SHORT BUT ACCEPTABLE	TOO SHORT



7. DIGIT 1 CIRCUMFERENCE:

--------1----------2----------3----------4----------5--------

TOO LOOSE	TOO LOOSE BUT ACCEPTABLE	JUST RIGHT	TOO TIGHT BUT ACCEPTABLE	TOO TIGHT

8. DIGIT 2 CIRCUMFERENCE:

--------1----------2----------3----------4----------5--------

TOO LOOSE	TOO LOOSE BUT ACCEPTABLE	JUST RIGHT	TOO TIGHT BUT ACCEPTABLE	TOO TIGHT

9. DIGIT 3 CIRCUMFERENCE:

--------1----------2----------3----------4----------5--------

TOO LOOSE	TOO LOOSE BUT ACCEPTABLE	JUST RIGHT	TOO TIGHT BUT ACCEPTABLE	TOO TIGHT

10. DIGIT 4 CIRCUMFERENCE:

--------1----------2----------3----------4----------5--------

TOO LOOSE	TOO LOOSE BUT ACCEPTABLE	JUST RIGHT	TOO TIGHT BUT ACCEPTABLE	TOO TIGHT

11. DIGIT 5 CIRCUMFERENCE:

--------1----------2----------3----------4----------5--------

TOO LOOSE	TOO LOOSE BUT ACCEPTABLE	JUST RIGHT	TOO TIGHT BUT ACCEPTABLE	TOO TIGHT

12. PALM CIRCUMFERENCE:

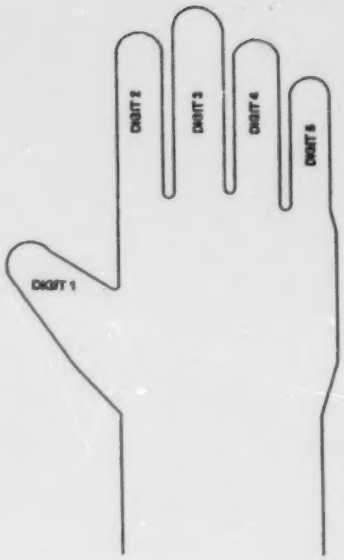
--------1----------2----------3----------4----------5--------

TOO LOOSE	TOO LOOSE BUT ACCEPTABLE	JUST RIGHT	TOO TIGHT BUT ACCEPTABLE	TOO TIGHT

13. WRIST CUFF:

--------1----------2----------3----------4----------5--------

TOO LOOSE	TOO LOOSE BUT ACCEPTABLE	JUST RIGHT	TOO TIGHT BUT ACCEPTABLE	TOO TIGHT



14. CROTCH OF THUMB:

--------1------—------2------------3------------4------------5--------

TOO HIGH	TOO HIGH BUT ACCEPTABLE	JUST RIGHT	TOO LOW BUT ACCEPTABLE	TOO LOW

15. CROTCH 2:

--------1------—------2------------3------------4------------5--------

TOO HIGH	TOO HIGH BUT ACCEPTABLE	JUST RIGHT	TOO LOW BUT ACCEPTABLE	TOO LOW

16. CROTCH 3:

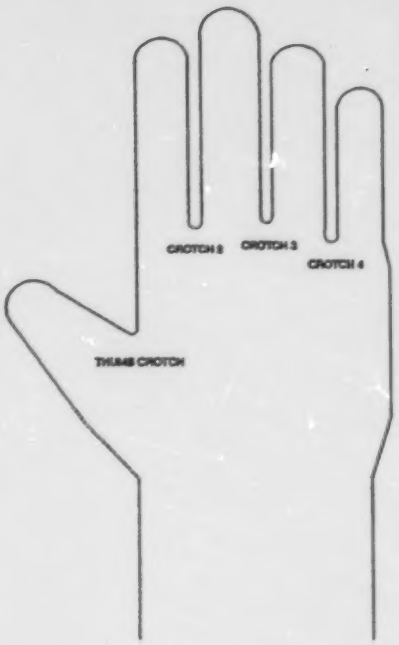
--------1------—------2------------3------------4------------5--------

TOO HIGH	TOO HIGH BUT ACCEPTABLE	JUST RIGHT	TOO LOW BUT ACCEPTABLE	TOO LOW

17. CROTCH 4:

--------1------—------2------------3------------4------------5--------

TOO HIGH	TOO HIGH BUT ACCEPTABLE	JUST RIGHT	TOO LOW BUT ACCEPTABLE	TOO LOW



18. Rate the comfort of this liner:

--------1------—------2------------3------—------4------------5--------

UNCOMFORTABLE				COMFORTABLE

19. Please feel free to add comments on the fit and function of the liner:

_____

_____

_____

APPENDIX H

QUESTIONNAIRE GENERAL COMMENTS

APPENDIX H : QUESTIONNAIRE GENERAL COMMENTS

L	M	M+L	
2	2	4	Right and left hand glove should be made available - seems to cause more fatigue
1	2	2	Performance hindered by excessive digit length (one subject - only digits 1,2,3 too long)
		1	Baggy palm may be a hinderance in other tasks
1			Glove functions a bit better than the molded because it is thinner
		2	Glove fits better with liner
	1		Pain in thumb reported, speculated that the thumb of glove is too short
	1		Molded glove very stiff and hard to flex digits - leads to fatigue in wrist and thumb
		1	Circumference of the finger is good on the bottom half, however the top half is too loose
	1		Index finger joint hurts due to pressure from the glove on joint
1			Prone to getting snagged in magazine loading
	2		Needs to be tighter in the finger tips to allow better control and feel for objects
1		1	Palm and thumb area could be looser for flexibility for continuous work
	1		Wrist and arm area should be widened to allow glove to fit over parka sleeve in arctic conditions - also different sizes required for women
	1	1	Needs ribs (texturing) on the finger tips and other pressure areas to improve grip
1			Excessive moisture develops in glove
	1		Obviously very bulky

APPENDIX I: Raw Data

Questionnaire Response Raw Data

APPENDIX I: Raw Data

IH DW C O N D	Q 1	Q 2	Q 3	Q 4	Q 5	Q 6	Q 7	Q 8	Q 9	Q 10	Q 11	Q 12	Q 13	Q 14	Q 15	Q 16
1 1	3.0	3.0	3.0	3.0	3.0	2.0	3.0	3.0	3.0	3.0	3.0	3.0	2.0	4.0	3.0	3.0
1 2	2.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.0	3.0	4.0	3.0
1 3	2.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
1 4	3.0	4.0	4.0	4.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.0	2.0	2.0
2 1	3.0	2.0	3.0	2.0	3.0	2.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.0	3.0
2 2	2.0	3.0	1.0	3.0	3.0	3.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0	3.0	2.0	3.0
2 3	2.0	3.0	1.0	3.0	3.0	2.0										
2 4	3.0	3.0	3.0	3.0	3.0	3.0										
3 1	2.0	3.0	1.0	1.0	1.0	1.0	2.0	2.0	2.0	2.0	2.0	3.0	2.0	3.0	2.0	2.0
3 2	3.0	1.0	1.0	1.0	1.0	1.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0	3.0	2.0	2.0
3 3	2.0	1.0	1.0	1.0	1.0	1.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.0	2.0	2.0
3 4	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
4 1	2.0	3.0	2.0	3.0	3.0	2.0	3.0	3.0	3.0	3.0	2.0	3.0	1.0	2.0	2.0	3.0
4 2	2.0	3.0	2.0	3.0	3.0	1.0	3.0	2.0	3.0	3.0	1.0	3.0	2.0	3.0	3.0	3.0
4 3	2.0	3.0	2.0	3.0	3.0	2.0	3.0	3.0	3.0	3.0	2.0	3.0	2.0	3.0	3.0	3.0
4 4	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.0	3.0
5 1	3.0	3.0	2.0	2.0	2.0	2.0	3.0	3.0	3.0	3.0	3.0	3.0	2.0	3.0	4.0	4.0
5 2	2.0	2.0	2.0	2.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.0	2.0
5 3	1.0	1.0	2.0	2.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
5 4	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
6 1	2.0	3.0	2.0	3.0	3.0	1.0	3.0	3.0	3.0	3.0	2.0	3.0	3.0	3.0	3.0	3.0
6 2	3.0	3.0	2.0	3.0	2.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0	3.0
6 3	2.0	3.0	1.0	3.0	1.0	1.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
6 4	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
7 1	3.0	5.0	3.0	4.0	3.0	2.0	4.0	2.0	2.0	2.0	2.0	4.0	2.0	2.0	2.0	3.0
7 2	3.0	5.0	2.0	2.0	2.0	1.0	3.0	2.0	2.0	2.0	2.0	3.0	4.0	4.0	3.0	3.0
7 3	3.0	5.0	3.0	2.0	2.0	1.0	3.0	2.0	3.0	2.0	3.0	4.0	3.0	4.0	3.0	3.0
7 4	3.0	4.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	4.0	3.0	2.0	2.0
8 1	2.0	3.0	3.0	3.0	3.0	2.0	2.0	2.0	2.0	2.0	3.0	2.0	1.0	3.0	3.0	3.0
8 2	1.0	3.0	3.0	3.0	3.0	2.0	3.0	3.0	3.0	3.0	3.0	3.0	4.0	3.0	3.0	3.0
8 3	2.0	3.0	3.0	3.0	3.0	3.0	2.0	2.0	2.0	2.0	3.0	3.0	2.0	3.0	3.0	3.0
8 4	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
9 1	2.0	4.0	3.0	4.0	4.0	3.0	5.0	2.0	3.0	3.0	3.0	4.0	2.0	1.0	2.0	2.0
9 2	3.0	5.0	2.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	1.0	1.0	1.0	3.0	3.0
9 3	3.0	5.0	4.0	4.0	4.0	4.0	5.0	3.0	3.0	3.0	3.0	4.0	4.0	1.0	2.0	2.0
9 4	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
10 1	3.0	4.0	2.5	3.5	3.0	2.0	3.0	2.0	3.0	2.0	2.0	2.5	2.5	2.0	2.0	2.5
10 2	2.0	3.0	1.5	3.0	2.5	1.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
10 3	2.0	3.0	2.0	3.5	2.0	1.5	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.5	3.5
10 4	3.5	3.5	3.5	3.5	3.5	3.5	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.0	2.0	2.0
11 1	5.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.0	3.0	3.0
11 2	2.0	3.0	2.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	5.0	3.0	1.0	3.0	3.0
11 3	5.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	5.0	5.0	1.0	3.0	3.0
11 4	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
12 1	2.0	3.0	3.0	3.0	3.0	2.0	3.0	3.0	3.0	3.0	1.0	3.0	3.0	3.0	2.0	2.0

Questionnaire Response Raw Data

IH	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
DW	1	2	3	4	5	6	7	8	9	1	1	1	1	1	1
C										0	1	2	3	4	5	6
O																
N																
D																
12 2	2.0	3.0	2.0	2.0	1.0	1.0	3.0	2.0	2.0	1.0	1.0	3.0	3.0	2.0	3.0	2.0
12 3	1.0	3.0	1.0	2.0	3.0	1.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.0	2.0	3.0
12 4	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
13 1	2.0	3.0	3.0	3.0	3.0	2.0	2.0	2.0	2.0	2.0	2.0	3.0	2.0	2.0	2.0	2.0
13 2	3.0	3.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	3.0	1.0	2.0	3.0	3.0
13 3	2.0	3.0	2.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	3.0	2.0	2.0	3.0	3.0
13 4	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.0	3.0	2.0	3.0	3.0
14 1	2.0	3.0	2.0	3.0	2.0	2.0	4.0	4.0	4.0	4.0	3.0	4.0	2.0	2.0	3.0	3.0
14 2	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.0	2.0	2.0	2.0
14 3	2.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0	3.0	3.0	3.0	4.0	2.0	3.0	2.0	2.0
14 4	1.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
15 1	1.5	3.5	3.0	3.0	3.0	3.0	2.0	2.0	3.0	3.0	3.0	3.0	1.0	3.0	1.0	2.0
15 2	3.0	3.0	2.0	3.0	3.0	1.0	2.0	1.0	1.0	3.0	3.0	2.0	2.0	3.0	3.0	3.0
15 3	3.0		3.0	2.0	3.0	2.0	2.0	2.0	2.0		2.0	3.0	3.0	3.0	3.0	3.0
15 4	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0

Questionnaire Response Raw Data

[H D W C O N D	Q 1 7	Q 1 8	Q 1 9
1 1	2.0	3.0	3.0
1 2	3.0	3.0	3.0
1 3	4.0	3.0	4.0
1 4	2.0		5.0
2 1	3.0	3.0	3.0
2 2	3.0	2.0	4.0
2 3			
2 4			
3 1	2.0	3.0	3.0
3 2	2.0	2.0	3.0
3 3	2.0	2.0	3.0
3 4	3.0		5.0
4 1	2.0	3.0	3.0
4 2	2.0	3.0	4.0
4 3	2.0	3.0	4.0
4 4	3.0		5.0
5 1	4.0	3.0	3.0
5 2	2.0	2.0	4.0
5 3	3.0	2.0	5.0
5 4	3.0		5.0
6 1	3.0	3.0	4.0
6 2	3.0	2.0	2.0
6 3	3.0	3.0	3.0
6 4	3.0		5.0
7 1	3.0	3.0	3.0
7 2	3.0	2.0	2.0
7 3	3.0	2.0	3.0
7 4	2.0		4.0
8 1	3.0	3.0	4.5
8 2	3.0	2.0	4.5
8 3	3.0	2.0	4.0
8 4	3.0		5.0
9 1	2.0	3.0	2.0
9 2	3.0	3.0	1.0
9 3	2.0	3.0	2.0
9 4	3.0		4.0
10 1	2.5	2.5	2.0
10 2	3.0	2.5	2.0
10 3	3.5	2.5	4.0
10 4	2.0		4.5
11 1	3.0	1.0	1.0
11 2	3.0	1.0	5.0
11 3	3.0	1.0	1.0
11 4	3.0		5.0
12 1	3.0	3.0	4.0

Questionnaire Response Raw Data

ID	HW	Q1C	Q1D	Q1N	Q1D
12	2	2.0	2.0		4.0
12	3	3.0	2.0		4.0
12	4	3.0			5.0
13	1	2.0	3.0		4.0
13	2	2.0	3.0		3.0
13	3	3.0	3.0		3.0
13	4	2.0			5.0
14	1	3.0	3.0		4.0
14	2	2.0	2.0		4.0
14	3	2.0	2.0		4.0
14	4	3.0			5.0
15	1	3.0	3.0		4.0
15	2	3.0	2.0		4.0
15	3	2.0	1.0		3.0
15	4	3.0			5.0

DEXTERITY TEST RAW DATA

ID	TEST	HWCOND	TRIAL	TIME
1	1	1	1	47.30
1	1	1	2	45.90
1	1	1	3	42.00
1	1	1	4	38.00
1	1	1	5	40.00
1	2	1	1	79.00
1	2	1	2	76.00
1	2	1	3	75.20
1	2	1	4	73.90
1	2	1	5	57.90
1	3	1	1	64.50
1	3	1	2	60.72
1	3	1	3	61.40
1	3	1	4	60.00
1	3	1	5	52.10
1	4	1	1	37.60
1	4	1	2	34.20
1	4	1	3	29.00
1	4	1	4	30.80
1	4	1	5	31.40
1	1	2	1	53.00
1	1	2	2	49.50
1	1	2	3	46.20
1	1	2	4	47.70
1	1	2	5	42.70
1	2	2	1	81.00
1	2	2	2	96.50
1	2	2	3	78.20
1	2	2	4	69.00
1	2	2	5	78.60
1	3	2	1	102.10
1	3	2	2	95.50
1	3	2	3	83.10
1	3	2	4	90.50
1	3	2	5	98.54
1	4	2	1	36.90
1	4	2	2	42.44
1	4	2	3	38.80
1	4	2	4	37.20
1	4	2	5	33.10
1	1	3	1	76.50
1	1	3	2	73.10
1	1	3	3	66.00
1	1	3	4	53.30
1	1	3	5	57.00

DEXTERITY TEST RAW DATA

ID	TEST	HWCOND	TRIAL	TIME
1	2	3	1	86.90
1	2	3	2	103.00
1	2	3	3	94.10
1	2	3	4	85.30
1	2	3	5	94.70
1	3	3	1	138.30
1	3	3	2	127.20
1	3	3	3	116.80
1	3	3	4	123.50
1	3	3	5	126.20
1	4	3	1	45.60
1	4	3	2	44.70
1	4	3	3	44.10
1	4	3	4	44.30
1	4	3	5	47.60
1	1	4	1	66.10
1	1	4	2	62.10
1	1	4	3	70.10
1	1	4	4	60.80
1	1	4	5	59.30
1	2	4	1	105.80
1	2	4	2	105.90
1	2	4	3	100.80
1	2	4	4	91.20
1	2	4	5	92.50
1	3	4	1	121.30
1	3	4	2	131.20
1	3	4	3	115.10
1	3	4	4	113.60
1	3	4	5	115.20
1	4	4	1	48.00
1	4	4	2	46.10
1	4	4	3	44.90
1	4	4	4	50.70
1	4	4	5	43.90
2	1	1	1	50.00
2	1	1	2	43.40
2	1	1	3	41.90
2	1	1	4	37.60
2	1	1	5	37.70
2	2	1	1	76.50
2	2	1	2	66.10
2	2	1	3	60.50
2	2	1	4	74.90
2	2	1	5	69.20

DEXTERITY TEST RAW DATA

ID	TEST	HWCOND	TRIAL	TIME
2	3	1	1	63.00
2	3	1	2	71.30
2	3	1	3	62.10
2	3	1	4	48.30
2	3	1	5	53.60
2	4	1	1	41.60
2	4	1	2	35.10
2	4	1	3	36.30
2	4	1	4	34.80
2	4	1	5	34.90
2	1	2	1	60.30
2	1	2	2	59.80
2	1	2	3	48.70
2	1	2	4	47.10
2	1	2	5	53.50
2	2	2	1	74.50
2	2	2	2	94.30
2	2	2	3	89.60
2	2	2	4	84.90
2	2	2	5	84.00
2	3	2	1	154.50
2	3	2	2	151.90
2	3	2	3	68.40
2	3	2	4	74.70
2	3	2	5	73.50
2	4	2	1	44.80
2	4	2	2	50.80
2	4	2	3	42.12
2	4	2	4	38.70
2	4	2	5	44.90
2	1	3	1	83.50
2	1	3	2	79.90
2	1	3	3	70.60
2	1	3	4	64.30
2	1	3	5	57.10
2	2	3	1	109.30
2	2	3	2	108.00
2	2	3	3	95.20
2	2	3	4	88.50
2	2	3	5	87.20
2	3	3	1	141.70
2	3	3	2	119.30
2	3	3	3	98.20
2	3	3	4	90.00
2	3	3	5	102.20

DEXTERITY TEST RAW DATA

ID	TEST	HWCOND	TRIAL	TIME
2	4	3	1	51.70
2	4	3	2	58.40
2	4	3	3	43.20
2	4	3	4	49.40
2	4	3	5	38.70
2	1	4	1	85.40
2	1	4	2	73.50
2	1	4	3	68.10
2	1	4	4	57.70
2	1	4	5	67.60
2	2	4	1	132.80
2	2	4	2	134.10
2	2	4	3	105.30
2	2	4	4	105.30
2	2	4	5	99.20
2	3	4	1	124.60
2	3	4	2	125.10
2	3	4	3	123.40
2	3	4	4	112.30
2	3	4	5	88.70
2	4	4	1	56.00
2	4	4	2	52.70
2	4	4	3	43.80
2	4	4	4	53.50
2	4	4	5	45.10
3	1	1	1	46.20
3	1	1	2	42.60
3	1	1	3	35.20
3	1	1	4	35.80
3	1	1	5	35.50
3	2	1	1	88.20
3	2	1	2	78.30
3	2	1	3	65.90
3	2	1	4	61.50
3	2	1	5	63.10
3	3	1	1	62.20
3	3	1	2	64.50
3	3	1	3	55.30
3	3	1	4	54.60
3	3	1	5	52.00
3	4	1	1	42.00
3	4	1	2	47.90
3	4	1	3	50.00
3	4	1	4	38.00
3	4	1	5	37.90

DEXTERITY TEST RAW DATA

ID	TEST	HAND	TRIAL	TIME
3	1	2	1	56.00
3	1	2	2	51.40
3	1	2	3	44.30
3	1	2	4	44.40
3	1	2	5	42.70
3	2	2	1	89.20
3	2	2	2	100.00
3	2	2	3	85.40
3	2	2	4	76.10
3	2	2	5	84.40
3	3	2	1	101.30
3	3	2	2	94.80
3	3	2	3	79.60
3	3	2	4	73.50
3	3	2	5	78.00
3	4	2	1	51.00
3	4	2	2	52.50
3	4	2	3	46.70
3	4	2	4	51.20
3	4	2	5	48.90
3	1	3	1	71.90
3	1	3	2	80.20
3	1	3	3	50.40
3	1	3	4	56.30
3	1	3	5	65.70
3	2	3	1	107.20
3	2	3	2	92.50
3	2	3	3	83.30
3	2	3	4	92.40
3	2	3	5	87.30
3	3	3	1	116.10
3	3	3	2	112.50
3	3	3	3	102.50
3	3	3	4	104.70
3	3	3	5	97.30
3	4	3	1	45.10
3	4	3	2	55.60
3	4	3	3	51.20
3	4	3	4	51.10
3	4	3	5	47.80
3	1	4	1	61.70
3	1	4	2	58.60
3	1	4	3	63.20
3	1	4	4	58.50
3	1	4	5	59.50

DEXTERITY TEST RAW DATA

ID	TEST	HWCOND	TRIAL	TIME
3	2	4	1	103.60
3	2	4	2	121.50
3	2	4	3	89.00
3	2	4	4	85.80
3	2	4	5	101.90
3	3	4	1	137.20
3	3	4	2	107.60
3	3	4	3	113.50
3	3	4	4	105.10
3	3	4	5	90.30
3	4	4	1	45.10
3	4	4	2	59.80
3	4	4	3	49.50
3	4	4	4	59.90
3	4	4	5	56.70
4	1	1	1	39.90
4	1	1	2	41.20
4	1	1	3	38.30
4	1	1	4	37.10
4	1	1	5	36.90
4	2	1	1	77.90
4	2	1	2	75.00
4	2	1	3	73.10
4	2	1	4	76.20
4	2	1	5	65.80
4	3	1	1	83.20
4	3	1	2	63.60
4	3	1	3	69.00
4	3	1	4	58.10
4	3	1	5	64.00
4	4	1	1	47.10
4	4	1	2	43.10
4	4	1	3	42.00
4	4	1	4	39.00
4	4	1	5	44.50
4	1	2	1	63.00
4	1	2	2	55.30
4	1	2	3	56.20
4	1	2	4	46.50
4	1	2	5	48.50
4	2	2	1	100.80
4	2	2	2	81.40
4	2	2	3	100.30
4	2	2	4	107.00
4	2	2	5	82.00

DEXTERITY TEST RAW DATA

ID	TEST	HWCOND	TRIAL	TIME
4	3	2	1	118.90
4	3	2	2	102.90
4	3	2	3	98.60
4	3	2	4	91.70
4	3	2	5	88.50
4	4	2	1	52.10
4	4	2	2	49.70
4	4	2	3	53.80
4	4	2	4	65.60
4	4	2	5	47.30
4	1	3	1	69.70
4	1	3	2	64.20
4	1	3	3	50.30
4	1	3	4	60.60
4	1	3	5	53.10
4	2	3	1	101.80
4	2	3	2	100.80
4	2	3	3	95.70
4	2	3	4	78.30
4	2	3	5	77.80
4	3	3	1	148.90
4	3	3	2	135.30
4	3	3	3	121.20
4	3	3	4	110.00
4	3	3	5	105.10
4	4	3	1	59.70
4	4	3	2	58.50
4	4	3	3	59.30
4	4	3	4	59.50
4	4	3	5	66.50
4	1	4	1	62.30
4	1	4	2	61.20
4	1	4	3	55.70
4	1	4	4	47.30
4	1	4	5	52.20
4	2	4	1	103.00
4	2	4	2	93.80
4	2	4	3	98.00
4	2	4	4	78.10
4	2	4	5	91.00
4	3	4	1	178.90
4	3	4	2	173.00
4	3	4	3	119.80
4	3	4	4	127.70
4	3	4	5	110.40

DEXTERITY TEST RAW DATA

ID	TEST	HWCOND	TRIAL	TIME
4	4	4	1	64.30
4	4	4	2	55.70
4	4	4	3	55.30
4	4	4	4	61.00
4	4	4	5	61.40
5	1	1	1	52.40
5	1	1	2	42.90
5	1	1	3	40.30
5	1	1	4	40.10
5	1	1	5	40.20
5	2	1	1	75.00
5	2	1	2	66.80
5	2	1	3	64.00
5	2	1	4	61.80
5	2	1	5	54.70
5	3	1	1	82.80
5	3	1	2	67.80
5	3	1	3	52.10
5	3	1	4	57.40
5	3	1	5	51.40
5	4	1	1	61.50
5	4	1	2	51.00
5	4	1	3	49.30
5	4	1	4	49.20
5	4	1	5	53.40
5	1	2	1	59.60
5	1	2	2	58.70
5	1	2	3	50.50
5	1	2	4	50.00
5	1	2	5	48.30
5	2	2	1	75.70
5	2	2	2	65.30
5	2	2	3	82.80
5	2	2	4	76.50
5	2	2	5	79.10
5	3	2	1	89.60
5	3	2	2	97.40
5	3	2	3	84.00
5	3	2	4	83.40
5	3	2	5	88.80
5	4	2	1	62.00
5	4	2	2	67.50
5	4	2	3	50.40
5	4	2	4	47.60
5	4	2	5	49.00

DEXTERITY TEST RAW DATA

ID	TEST	HWC DND	TRIAL	TIME
5	1	3	1	77.20
5	1	3	2	77.90
5	1	3	3	76.20
5	1	3	4	75.40
5	1	3	5	79.20
5	2	3	1	86.50
5	2	3	2	101.80
5	2	3	3	87.30
5	2	3	4	78.40
5	2	3	5	85.80
5	3	3	1	133.90
5	3	3	2	164.10
5	3	3	3	123.70
5	3	3	4	120.90
5	3	3	5	128.40
5	4	3	1	64.90
5	4	3	2	74.00
5	4	3	3	55.80
5	4	3	4	59.80
5	4	3	5	60.80
5	1	4	1	78.30
5	1	4	2	86.70
5	1	4	3	68.90
5	1	4	4	57.00
5	1	4	5	59.80
5	2	4	1	105.60
5	2	4	2	92.00
5	2	4	3	86.50
5	2	4	4	90.90
5	2	4	5	102.30
5	3	4	1	175.30
5	3	4	2	115.70
5	3	4	3	103.60
5	3	4	4	131.00
5	3	4	5	124.70
5	4	4	1	70.70
5	4	4	2	67.00
5	4	4	3	62.20
5	4	4	4	83.90
5	4	4	5	66.50
6	1	1	1	40.90
6	1	1	2	33.90
6	1	1	3	31.00
6	1	1	4	29.40
6	1	1	5	28.10

DEXTERITY TEST RAW DATA

ID	TEST	HWCOND	TRIAL	TIME
6	2	1	1	71.70
6	2	1	2	60.20
6	2	1	3	55.50
6	2	1	4	57.80
6	2	1	5	60.40
6	3	1	1	66.60
6	3	1	2	50.80
6	3	1	3	43.90
6	3	1	4	42.20
6	3	1	5	39.10
6	4	1	1	35.10
6	4	1	2	36.30
6	4	1	3	33.70
6	4	1	4	26.22
6	4	1	5	29.20
6	1	2	1	47.70
6	1	2	2	41.40
6	1	2	3	37.70
6	1	2	4	35.00
6	1	2	5	37.70
6	2	2	1	79.30
6	2	2	2	73.60
6	2	2	3	70.10
6	2	2	4	66.20
6	2	2	5	70.90
6	3	2	1	80.80
6	3	2	2	82.20
6	3	2	3	57.50
6	3	2	4	56.90
6	3	2	5	54.70
6	4	2	1	48.70
6	4	2	2	41.70
6	4	2	3	38.50
6	4	2	4	33.60
6	4	2	5	33.50
6	1	3	1	49.60
6	1	3	2	52.70
6	1	3	3	46.00
6	1	3	4	42.30
6	1	3	5	46.30
6	2	3	1	105.50
6	2	3	2	113.60
6	2	3	3	77.10
6	2	3	4	74.00
6	2	3	5	72.00

DEXTERITY TEST RAW DATA

ID	TEST	HAND	TRIAL	TIME
6	3	3	1	113.30
6	3	3	2	90.10
6	3	3	3	89.30
6	3	3	4	81.10
6	3	3	5	88.80
6	4	3	1	58.50
6	4	3	2	44.40
6	4	3	3	36.60
6	4	3	4	35.60
6	4	3	5	52.90
6	1	4	1	49.40
6	1	4	2	44.40
6	1	4	3	53.30
6	1	4	4	53.50
6	1	4	5	54.20
6	2	4	1	119.70
6	2	4	2	111.90
6	2	4	3	84.00
6	2	4	4	77.60
6	2	4	5	77.70
6	3	4	1	98.50
6	3	4	2	94.40
6	3	4	3	79.40
6	3	4	4	93.30
6	3	4	5	78.20
6	4	4	1	47.50
6	4	4	2	42.00
6	4	4	3	44.02
6	4	4	4	37.40
6	4	4	5	40.20
7	1	1	1	49.70
7	1	1	2	43.00
7	1	1	3	46.60
7	1	1	4	41.80
7	1	1	5	38.50
7	2	1	1	82.20
7	2	1	2	81.70
7	2	1	3	79.60
7	2	1	4	69.10
7	2	1	5	63.50
7	3	1	1	73.00
7	3	1	2	62.90
7	3	1	3	60.00
7	3	1	4	55.90
7	3	1	5	67.10

DEXTERITY TEST RAW DATA

ID	TEST	HAND	TRIAL	TIME
7	4	1	1	37.90
7	4	1	2	39.40
7	4	1	3	41.60
7	4	1	4	37.90
7	4	1	5	37.70
7	1	2	1	60.40
7	1	2	2	53.40
7	1	2	3	47.40
7	1	2	4	49.20
7	1	2	5	47.40
7	2	2	1	89.00
7	2	2	2	87.80
7	2	2	3	94.20
7	2	2	4	98.20
7	2	2	5	98.90
7	3	2	1	90.30
7	3	2	2	83.80
7	3	2	3	84.20
7	3	2	4	69.90
7	3	2	5	66.70
7	4	2	1	55.70
7	4	2	2	55.90
7	4	2	3	52.40
7	4	2	4	51.70
7	4	2	5	42.10
7	1	3	1	64.00
7	1	3	2	62.90
7	1	3	3	59.30
7	1	3	4	55.30
7	1	3	5	60.40
7	2	3	1	106.60
7	2	3	2	124.20
7	2	3	3	87.00
7	2	3	4	92.30
7	2	3	5	85.10
7	3	3	1	98.00
7	3	3	2	97.80
7	3	3	3	87.50
7	3	3	4	88.90
7	3	3	5	87.60
7	4	3	1	56.30
7	4	3	2	63.30
7	4	3	3	55.40
7	4	3	4	48.10
7	4	3	5	57.80

DEXTERITY TEST RAW DATA

ID	TEST	HWCOND	TRIAL	TIME
7	1	4	1	65.30
7	1	4	2	63.20
7	1	4	3	66.00
7	1	4	4	74.30
7	1	4	5	65.60
7	2	4	1	123.90
7	2	4	2	100.50
7	2	4	3	85.90
7	2	4	4	76.70
7	2	4	5	77.60
7	3	4	1	106.20
7	3	4	2	105.30
7	3	4	3	163.00
7	3	4	4	89.80
7	3	4	5	90.80
7	4	4	1	62.80
7	4	4	2	61.60
7	4	4	3	55.50
7	4	4	4	53.40
7	4	4	5	61.10
8	1	1	1	51.50
8	1	1	2	47.10
8	1	1	3	43.40
8	1	1	4	40.20
8	1	1	5	42.80
8	2	1	1	73.40
8	2	1	2	72.00
8	2	1	3	69.00
8	2	1	4	77.80
8	2	1	5	82.90
8	3	1	1	68.10
8	3	1	2	60.30
8	3	1	3	46.20
8	3	1	4	46.00
8	3	1	5	53.30
8	4	1	1	39.30
8	4	1	2	42.70
8	4	1	3	39.70
8	4	1	4	30.80
8	4	1	5	34.40
8	1	2	1	55.80
8	1	2	2	55.20
8	1	2	3	60.60
8	1	2	4	52.60
8	1	2	5	55.20

DEXTERITY TEST RAW DATA

ID	TEST	HW CONDD	TRIAL	TIME
8	2	2	1	100.40
8	2	2	2	83.30
8	2	2	3	77.90
8	2	2	4	73.50
8	2	2	5	70.90
8	3	2	1	81.10
8	3	2	2	75.90
8	3	2	3	63.20
8	3	2	4	63.70
8	3	2	5	66.40
8	4	2	1	45.90
8	4	2	2	49.60
8	4	2	3	60.00
8	4	2	4	52.70
8	4	2	5	48.00
8	1	3	1	80.80
8	1	3	2	63.00
8	1	3	3	60.60
8	1	3	4	49.30
8	1	3	5	54.80
8	2	3	1	94.10
8	2	3	2	103.00
8	2	3	3	99.20
8	2	3	4	93.20
8	2	3	5	86.30
8	3	3	1	115.80
8	3	3	2	111.50
8	3	3	3	83.10
8	3	3	4	90.20
8	3	3	5	93.70
8	4	3	1	52.30
8	4	3	2	62.10
8	4	3	3	56.70
8	4	3	4	52.70
8	4	3	5	54.10
8	1	4	1	73.50
8	1	4	2	59.20
8	1	4	3	49.00
8	1	4	4	56.70
8	1	4	5	58.30
8	2	4	1	106.70
8	2	4	2	124.20
8	2	4	3	108.70
8	2	4	4	111.30
8	2	4	5	109.70

DEXTERITY TEST RAW DATA

ID	TEST	HWCOND	TRIAL	TIME
8	3	4	1	108.60
8	3	4	2	118.50
8	3	4	3	126.20
8	3	4	4	109.90
8	3	4	5	102.70
8	4	4	1	41.20
8	4	4	2	50.10
8	4	4	3	60.50
8	4	4	4	64.60
8	4	4	5	61.30
9	1	1	1	62.90
9	1	1	2	65.80
9	1	1	3	42.30
9	1	1	4	39.80
9	1	1	5	41.00
9	2	1	1	73.40
9	2	1	2	70.40
9	2	1	3	65.70
9	2	1	4	59.40
9	2	1	5	54.60
9	3	1	1	85.60
9	3	1	2	65.90
9	3	1	3	50.30
9	3	1	4	56.30
9	3	1	5	55.50
9	4	1	1	50.30
9	4	1	2	39.50
9	4	1	3	34.30
9	4	1	4	31.10
9	4	1	5	36.00
9	1	2	1	82.40
9	1	2	2	75.50
9	1	2	3	59.90
9	1	2	4	47.00
9	1	2	5	48.80
9	2	2	1	92.30
9	2	2	2	73.70
9	2	2	3	64.30
9	2	2	4	78.90
9	2	2	5	73.80
9	3	2	1	116.00
9	3	2	2	144.80
9	3	2	3	74.90
9	3	2	4	75.40
9	3	2	5	70.30

DEXTERITY TEST RAW DATA

ID	TEST	HWCOND	TRIAL	TIME
9	4	2	1	57.70
9	4	2	2	60.40
9	4	2	3	52.00
9	4	2	4	49.80
9	4	2	5	49.90
9	1	3	1	84.20
9	1	3	2	72.10
9	1	3	3	58.20
9	1	3	4	56.10
9	1	3	5	63.00
9	2	3	1	79.70
9	2	3	2	84.60
9	2	3	3	88.20
9	2	3	4	73.20
9	2	3	5	93.00
9	3	3	1	158.40
9	3	3	2	137.00
9	3	3	3	92.90
9	3	3	4	79.00
9	3	3	5	80.10
9	4	3	1	59.20
9	4	3	2	63.90
9	4	3	3	58.60
9	4	3	4	51.50
9	4	3	5	55.00
9	1	4	1	72.40
9	1	4	2	62.70
9	1	4	3	65.80
9	1	4	4	55.50
9	1	4	5	57.10
9	2	4	1	86.70
9	2	4	2	95.10
9	2	4	3	86.70
9	2	4	4	86.50
9	2	4	5	98.00
9	3	4	1	117.00
9	3	4	2	128.40
9	3	4	3	112.00
9	3	4	4	102.00
9	3	4	5	109.20
9	4	4	1	73.40
9	4	4	2	65.00
9	4	4	3	56.50
9	4	4	4	54.60
9	4	4	5	49.20

DEXTERITY TEST RAW DATA

ID	TEST	HWCOND	TRIAL	TIME
10	1	1	1	45.30
10	1	1	2	39.80
10	1	1	3	36.60
10	1	1	4	36.40
10	1	1	5	36.10
10	2	1	1	77.10
10	2	1	2	74.10
10	2	1	3	57.80
10	2	1	4	61.90
10	2	1	5	55.80
10	3	1	1	76.60
10	3	1	2	66.80
10	3	1	3	51.70
10	3	1	4	58.70
10	3	1	5	51.90
10	4	1	1	50.80
10	4	1	2	38.30
10	4	1	3	30.30
10	4	1	4	30.10
10	4	1	5	28.40
10	1	2	1	50.50
10	1	2	2	47.80
10	1	2	3	39.40
10	1	2	4	37.70
10	1	2	5	42.10
10	2	2	1	89.70
10	2	2	2	91.00
10	2	2	3	82.00
10	2	2	4	78.50
10	2	2	5	68.10
10	3	2	1	101.20
10	3	2	2	67.00
10	3	2	3	83.60
10	3	2	4	70.70
10	3	2	5	66.30
10	4	2	1	58.40
10	4	2	2	62.80
10	4	2	3	38.20
10	4	2	4	47.10
10	4	2	5	36.10
10	1	3	1	55.80
10	1	3	2	51.70
10	1	3	3	44.60
10	1	3	4	43.30
10	1	3	5	42.90

DEXTERITY TEST RAW DATA

ID	TEST	HWCOND	TRIAL	TIME
10	2	3	1	99.60
10	2	3	2	83.70
10	2	3	3	75.20
10	2	3	4	84.20
10	2	3	5	84.60
10	3	3	1	104.70
10	3	3	2	89.30
10	3	3	3	75.10
10	3	3	4	65.00
10	3	3	5	75.40
10	4	3	1	52.30
10	4	3	2	46.00
10	4	3	3	37.50
10	4	3	4	33.40
10	4	3	5	37.10
10	1	4	1	59.40
10	1	4	2	54.00
10	1	4	3	52.70
10	1	4	4	43.90
10	1	4	5	48.50
10	2	4	1	105.80
10	2	4	2	84.70
10	2	4	3	95.30
10	2	4	4	73.90
10	2	4	5	85.10
10	3	4	1	91.70
10	3	4	2	89.30
10	3	4	3	99.00
10	3	4	4	88.00
10	3	4	5	93.60
10	4	4	1	43.60
10	4	4	2	41.80
10	4	4	3	38.50
10	4	4	4	42.90
10	4	4	5	41.30
11	1	1	1	86.20
11	1	1	2	67.30
11	1	1	3	67.70
11	1	1	4	65.70
11	1	1	5	62.00
11	2	1	1	94.60
11	2	1	2	96.00
11	2	1	3	96.00
11	2	1	4	96.10
11	2	1	5	91.20

DEXTERITY TEST RAW DATA

ID	TEST	HWCOND	TRIAL	TIME
11	3	1	1	99.20
11	3	1	2	96.00
11	3	1	3	101.20
11	3	1	4	92.90
11	3	1	5	88.80
11	4	1	1	49.80
11	4	1	2	51.90
11	4	1	3	45.88
11	4	1	4	50.10
11	4	1	5	44.70
11	1	2	1	80.40
11	1	2	2	71.90
11	1	2	3	67.90
11	1	2	4	65.10
11	1	2	5	62.70
11	2	2	1	126.40
11	2	2	2	127.40
11	2	2	3	129.40
11	2	2	4	107.30
11	2	2	5	91.70
11	3	2	1	122.90
11	3	2	2	126.80
11	3	2	3	112.60
11	3	2	4	113.60
11	3	2	5	102.70
11	4	2	1	56.60
11	4	2	2	60.10
11	4	2	3	54.30
11	4	2	4	59.30
11	4	2	5	62.20
11	1	3	1	83.90
11	1	3	2	86.90
11	1	3	3	94.90
11	1	3	4	84.00
11	1	3	5	91.70
11	2	3	1	176.30
11	2	3	2	155.30
11	2	3	3	133.70
11	2	3	4	141.20
11	2	3	5	124.20
11	3	3	1	165.30
11	3	3	2	163.70
11	3	3	3	144.40
11	3	3	4	132.70
11	3	3	5	145.90

DEXTERITY TEST RAW DATA

ID	TEST	HMCDND	TRIAL	TIME
11	4	3	1	80.30
11	4	3	2	68.60
11	4	3	3	64.60
11	4	3	4	74.20
11	4	3	5	78.00
11	1	4	1	110.60
11	1	4	2	107.10
11	1	4	3	111.30
11	1	4	4	110.30
11	1	4	5	103.70
11	2	4	1	135.10
11	2	4	2	125.50
11	2	4	3	160.10
11	2	4	4	137.60
11	2	4	5	152.90
11	3	4	1	146.90
11	3	4	2	177.20
11	3	4	3	147.00
11	3	4	4	173.90
11	3	4	5	155.60
11	4	4	1	82.40
11	4	4	2	68.70
11	4	4	3	60.40
11	4	4	4	81.90
11	4	4	5	83.10
12	1	1	1	44.10
12	1	1	2	37.20
12	1	1	3	38.60
12	1	1	4	37.10
12	1	1	5	35.80
12	2	1	1	62.80
12	2	1	2	65.40
12	2	1	3	58.70
12	2	1	4	65.90
12	2	1	5	61.60
12	3	1	1	75.10
12	3	1	2	80.60
12	3	1	3	59.60
12	3	1	4	66.20
12	3	1	5	58.60
12	4	1	1	37.20
12	4	1	2	32.40
12	4	1	3	34.60
12	4	1	4	32.60
12	4	1	5	34.80

DEXTERITY TEST RAW DATA

ID	TEST	HWCOND	TRIAL	TIME
12	1	2	1	55.70
12	1	2	2	53.30
12	1	2	3	44.40
12	1	2	4	41.30
12	1	2	5	44.20
12	2	2	1	92.70
12	2	2	2	98.10
12	2	2	3	78.60
12	2	2	4	77.70
12	2	2	5	70.00
12	3	2	1	122.20
12	3	2	2	98.70
12	3	2	3	69.70
12	3	2	4	78.60
12	3	2	5	64.20
12	4	2	1	43.30
12	4	2	2	40.90
12	4	2	3	38.90
12	4	2	4	35.80
12	4	2	5	39.70
12	1	3	1	68.40
12	1	3	2	69.40
12	1	3	3	52.30
12	1	3	4	47.40
12	1	3	5	46.70
12	2	3	1	116.00
12	2	3	2	104.10
12	2	3	3	78.70
12	2	3	4	87.40
12	2	3	5	78.40
12	3	3	1	133.90
12	3	3	2	107.80
12	3	3	3	87.40
12	3	3	4	76.40
12	3	3	5	80.70
12	4	3	1	43.50
12	4	3	2	49.50
12	4	3	3	48.10
12	4	3	4	43.00
12	4	3	5	38.00
12	1	4	1	68.70
12	1	4	2	70.30
12	1	4	3	64.30
12	1	4	4	48.30
12	1	4	5	52.80

DEXTERITY TEST RAW DATA

ID	TEST	HWCOND	TRIAL	TIME
12	2	4	1	97.80
12	2	4	2	106.00
12	2	4	3	95.40
12	2	4	4	85.90
12	2	4	5	75.70
12	3	4	1	142.10
12	3	4	2	119.00
12	3	4	3	114.20
12	3	4	4	91.30
12	3	4	5	89.60
12	4	4	1	42.60
12	4	4	2	40.70
12	4	4	3	42.40
12	4	4	4	45.10
12	4	4	5	37.10
13	1	1	1	47.10
13	1	1	2	40.50
13	1	1	3	40.70
13	1	1	4	38.00
13	1	1	5	36.40
13	2	1	1	69.30
13	2	1	2	61.40
13	2	1	3	56.20
13	2	1	4	63.70
13	2	1	5	61.50
13	3	1	1	71.50
13	3	1	2	58.90
13	3	1	3	56.80
13	3	1	4	58.40
13	3	1	5	51.70
13	4	1	1	44.20
13	4	1	2	38.40
13	4	1	3	37.90
13	4	1	4	39.10
13	4	1	5	34.10
13	1	2	1	56.80
13	1	2	2	54.60
13	1	2	3	44.90
13	1	2	4	48.80
13	1	2	5	45.50
13	2	2	1	88.10
13	2	2	2	78.80
13	2	2	3	65.40
13	2	2	4	79.90
13	2	2	5	78.90

DEXTERITY TEST RAW DATA

ID	TEST	HWCOND	TRIAL	TIME
13	3	2	1	86.20
13	3	2	2	88.80
13	3	2	3	53.20
13	3	2	4	55.20
13	3	2	5	61.40
13	4	2	1	51.70
13	4	2	2	46.60
13	4	2	3	42.40
13	4	2	4	39.50
13	4	2	5	45.40
13	1	3	1	69.70
13	1	3	2	69.10
13	1	3	3	65.60
13	1	3	4	67.70
13	1	3	5	59.60
13	2	3	1	95.30
13	2	3	2	94.20
13	2	3	3	70.40
13	2	3	4	79.70
13	2	3	5	79.00
13	3	3	1	119.70
13	3	3	2	103.50
13	3	3	3	75.60
13	3	3	4	75.30
13	3	3	5	79.10
13	4	3	1	55.60
13	4	3	2	64.20
13	4	3	3	60.90
13	4	3	4	51.30
13	4	3	5	54.30
13	1	4	1	74.40
13	1	4	2	73.30
13	1	4	3	63.40
13	1	4	4	61.40
13	1	4	5	58.90
13	2	4	1	94.00
13	2	4	2	98.30
13	2	4	3	86.50
13	2	4	4	79.60
13	2	4	5	90.70
13	3	4	1	104.70
13	3	4	2	88.10
13	3	4	3	79.00
13	3	4	4	78.80
13	3	4	5	76.10

DEXTERITY TEST RAW DATA

ID	TEST	HAND	TRIAL	TIME
13	4	4	1	56.10
13	4	4	2	68.00
13	4	4	3	50.50
13	4	4	4	49.10
13	4	4	5	51.10
14	1	1	1	55.20
14	1	1	2	49.50
14	1	1	3	46.00
14	1	1	4	43.60
14	1	1	5	39.80
14	2	1	1	90.90
14	2	1	2	80.10
14	2	1	3	66.20
14	2	1	4	75.60
14	2	1	5	81.30
14	3	1	1	75.10
14	3	1	2	61.50
14	3	1	3	68.60
14	3	1	4	63.90
14	3	1	5	65.50
14	4	1	1	59.00
14	4	1	2	54.80
14	4	1	3	45.60
14	4	1	4	45.00
14	4	1	5	44.90
14	1	2	1	60.20
14	1	2	2	63.80
14	1	2	3	52.20
14	1	2	4	49.10
14	1	2	5	48.30
14	2	2	1	95.30
14	2	2	2	96.60
14	2	2	3	84.40
14	2	2	4	80.00
14	2	2	5	83.60
14	3	2	1	95.70
14	3	2	2	95.80
14	3	2	3	97.20
14	3	2	4	91.90
14	3	2	5	94.00
14	4	2	1	58.00
14	4	2	2	65.10
14	4	2	3	49.10
14	4	2	4	53.20
14	4	2	5	54.30

DEXTERITY TEST RAW DATA

ID	TEST	HWCOND	TRIAL	TIME
14	1	3	1	72.90
14	1	3	2	67.80
14	1	3	3	60.50
14	1	3	4	55.50
14	1	3	5	55.60
14	2	3	1	96.60
14	2	3	2	106.70
14	2	3	3	85.30
14	2	3	4	88.70
14	2	3	5	89.10
14	3	3	1	162.00
14	3	3	2	130.60
14	3	3	3	126.40
14	3	3	4	133.70
14	3	3	5	134.40
14	4	3	1	84.40
14	4	3	2	53.80
14	4	3	3	65.40
14	4	3	4	72.80
14	4	3	5	58.40
14	1	4	1	70.40
14	1	4	2	65.00
14	1	4	3	60.20
14	1	4	4	59.80
14	1	4	5	61.80
14	2	4	1	98.70
14	2	4	2	90.90
14	2	4	3	104.60
14	2	4	4	101.90
14	2	4	5	104.90
14	3	4	1	172.30
14	3	4	2	178.90
14	3	4	3	132.30
14	3	4	4	156.40
14	3	4	5	144.90
14	4	4	1	64.10
14	4	4	2	53.70
14	4	4	3	55.90
14	4	4	4	83.60
14	4	4	5	77.30
15	1	1	1	47.04
15	1	1	2	41.40
15	1	1	3	44.10
15	1	1	4	42.10
15	1	1	5	40.40

DEXTERITY TEST RAW DATA

ID	TEST	HWCOND	TRIAL	TIME
15	2	1	1	88.30
15	2	1	2	77.90
15	2	1	3	76.60
15	2	1	4	58.40
15	2	1	5	61.30
15	3	1	1	89.40
15	3	1	2	65.40
15	3	1	3	65.80
15	3	1	4	60.30
15	3	1	5	54.00
15	4	1	1	53.00
15	4	1	2	46.00
15	4	1	3	40.40
15	4	1	4	37.30
15	4	1	5	34.40
15	1	2	1	53.50
15	1	2	2	49.50
15	1	2	3	55.00
15	1	2	4	53.10
15	1	2	5	48.30
15	2	2	1	88.90
15	2	2	2	93.80
15	2	2	3	81.60
15	2	2	4	75.30
15	2	2	5	76.00
15	3	2	1	100.90
15	3	2	2	91.90
15	3	2	3	76.80
15	3	2	4	86.70
15	3	2	5	75.30
15	4	2	1	53.30
15	4	2	2	58.30
15	4	2	3	50.60
15	4	2	4	52.30
15	4	2	5	43.70
15	1	3	1	64.80
15	1	3	2	69.20
15	1	3	3	55.40
15	1	3	4	56.00
15	1	3	5	63.30
15	2	3	1	121.70
15	2	3	2	91.60
15	2	3	3	87.60
15	2	3	4	88.30
15	2	3	5	87.90